

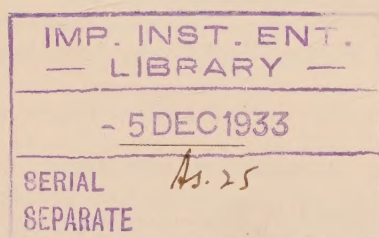


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The Philippine Agriculturist

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VOLUME XXI



JUNE, 1932 TO MARCH, 1933

(Complete in ten numbers)

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ERRATA

- Page 172, line 5 from top "family *Pythiaceae*" should read "family *Pythiaceae*".
- Page 172, line 3 from bottom "(*Rheosporangium aphanidermatum* Edson (1915); *Pythium butleri* Sub. (1919), and *Pythium arrhenomanes* Drechsler (1928) the Philippine corn *Pythium* is morphologically, etc." should read "(*Rheosporangium aphanidermatum* Edson) (1915) and *Pythium butleri* Sub. (1919), the Philippine corn *Pythium* is morphologically, etc."
- Page 242, line 8 from top "*Melanconium sacchari* Mass. (Fungi imperfecti), *Thielaviopsis paradoxa* Mass. (Ascomycetes), *Schizophyllum commune* Fries (Basidiomycetes), and *Rhizopus* sp. (Phycomycetes)" should read "*Melanconium sacchari* Mass. (Fungi imperfecti), *Ceratostomella paradoxa* Dade (Ascomycetes) = (*Thielaviopsis paradoxa* (De Seyn.) von Hoehnel) (Fungi imperfecti), *Schizophyllum commune* Fries (Basidiomycetes), and *Rhizopus* sp. (Phycomycetes)".
- Page 263, line 6 from bottom "Badila 147" should read "Barbados 147".
- Page 264, line 2 from bottom "Badila 147" should read "Barbados 147".
- Page 345, line 11 from top "*Musa sapientum* var. *lakatan* (Blanco) Teodoro" should read "*Musa sapientum* var. *lacatan* (Blanco) Teodoro".
- Page 489, line 18 from bottom "*Promecotheca cumingii* Baly" should read "*Promecotheca cumingii* Baly".
- Page 540, line 1 from bottom "Agriculturist Experiment Station" should read "Agricultural Experiment Station".
- Page 542, line 4 from bottom "Blight and root rot abacá seedlings" should read "Blight and root rot of abacá seedlings".
- Page 594, fig. 3 and page 605, line 7 from top "*Thielaviopsis paradoxa* (de Seynes Höh.)" should read "*Thielaviopsis paradoxa* (De Seynes) von Höh."
- Page 596, line 2 from top "figure 2" should read "figure 3".

THE ANIMAL IMPROVEMENT PROGRAM OF THE COLLEGE OF AGRICULTURE¹

Tropical people are essentially plant growers, devoting relatively little attention to the raising of live stock. Whether this is due to a peculiar feature of their civilization, or whether it is due to the relative abundance of wild animals, or because tropical peoples are naturally fonder of vegetables and fish than of meat as articles of diet, the fact remains that very little is known of modern animal husbandry in the tropics, and much less was known when the College of Agriculture was founded.

With this condition, to instruct students in the Philippines in modern methods of animal husbandry one must begin with the creation of conditions simulating the existence of a progressive industry. To do this involves adaptation of practices found successful elsewhere, when possible, and the discovery and adoption of new methods where the first ones fail. The program of animal improvement in the College of Agriculture centers around three main divisions: breed improvement, improved feeding methods, and disease control.

BREED IMPROVEMENT

It became patent very early in our work that imported breeds of swine from temperate countries were unsuitable for propagation in the tropics. Subsequent experience with other kinds of animals corroborated and strengthened this opinion. Largely because of this opinion, but in part because the importation of animals is at best irregular, difficult, and expensive, we have paid little attention to the acclimatization of Occidental pure breeds but have started on a program of establishing the foundation stock of what we hope will in time develop into standard breeds adapted to the Islands.

Our work in establishing a swine breed, which we call the Berkjala, has been carried on for seventeen years. As its name suggests, the original breeds used in this Berkjala make up are the Berkshire and the Jala-jala pig of Rizal in the proportion of approximately five-eighths and three-eighths, respectively. It would be interesting to recount how we arrived at this proportion, how we brought the proportion of Berkshire blood gradually to fifteen-sixteenths, and how we had to retrace our steps to the present proportion. It is a story of hopes and disillusion in succession, with the present animals, samples of which are now on exhibit at the Phil-

¹General contribution from College of Agriculture No. 309. An address delivered before the Philippine Veterinary Medical Association on February 5, 1932.

ippine Carnival Live Stock Show, as the reward for our efforts. Suffice it to say that we have now in the Berkjala a breed undergoing constant purification and improvement, and already better than the Berkshire or any other Occidental breed for the Philippines in ability to live, grow, and propagate under our conditions, and better than the native in rate of growth, size, and response to domestication and rational feeding. In short, it stands midway in merit between the Berkshire and the native pig, combining their desirable characters in so far as this is possible in one individual. The Berkjala is not to be confused with a newly formed grade. It has gone through not less than nine generations of constant and rigid selection.

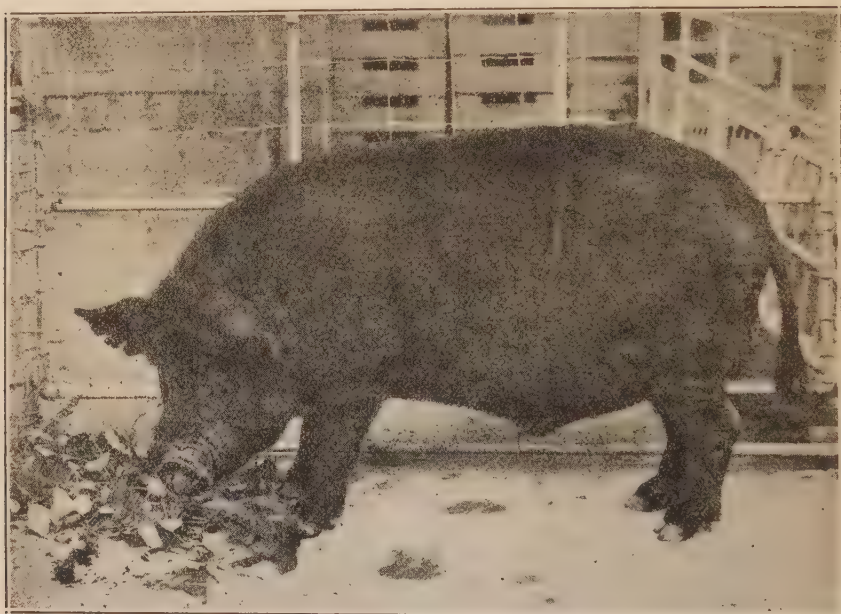


Fig. 1.—Berkjala boar, age 2 years. Weight, 175 kgm.

Those who have had experience in breeding animals will readily appreciate the difference between a so-called "mixed breed" and our present herd of Berkjala pigs.

We have started similar work on a breed of range cattle, as yet unnamed, using the Hereford, the Nellore, and the Philippine ox as sources of blood. This work dates as far back as 1920. Because this work was started later, and because the rate of propagation of cattle is naturally slower, progress in the formation of this breed of cattle will mark time.

Similar work with goats and dairy cattle is in progress but because this started recently, relatively, results are as yet visible only to the workers.

We have not abandoned entirely efforts at acclimatizing pure Occidental breeds. Our herd of pure Hereford cattle is now twelve years old, and our flocks of Single Comb White Leghorn and Barred Plymouth Rock chickens are about the same age. Neither cattle nor fowls have had the advantage of renovation by new importations. There are not many pure herds of Occidental breeds in the Islands as old as these.

In a previous paper on this subject² we stated "when the breeds imported (into the Philippines) are from tropical countries, such as India and China, the introductions have proved satisfactorily successful. Animals from these countries, however, are not markedly superior to the native

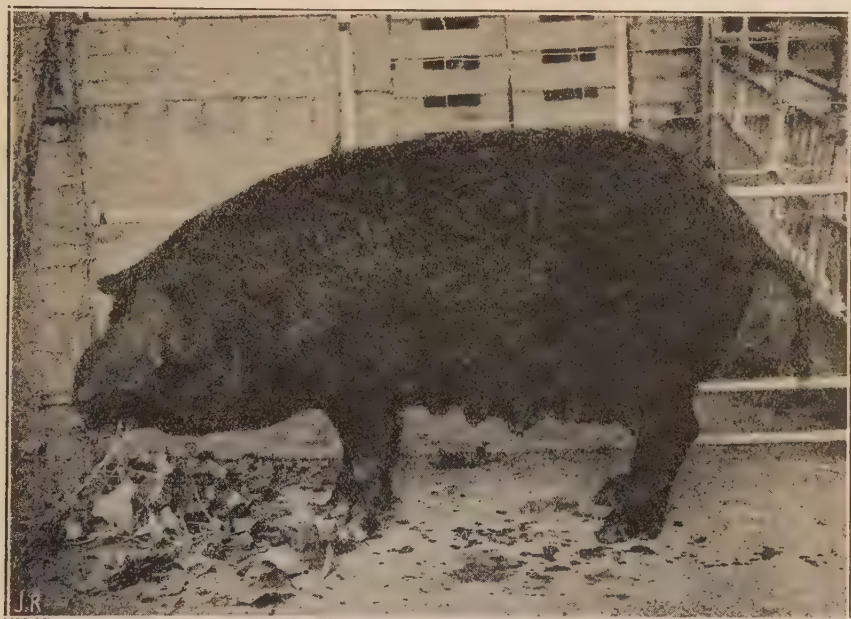


Fig. 2.—Berkjala sow, age $2\frac{1}{2}$ years. Weight, 170 kgm.

stock, and hence the resulting improvement, while obvious, is not outstanding." With this as a keynote of our attitude towards Oriental breeds, we have sought to utilize them in our breed improvement work in two ways: First, as foundation stock in the development of new breeds, and second, in their pure form through the agency of selection. In our work in developing a breed of range cattle for beef, and a dairy cattle breed, we utilize the Nellore to impart hardiness, good grazing qualities, and resistance to disease. And our improvement of the Cantonese breed of fowls through selection is

²Gonzalez, B. M. Experience in the Philippines with the introduction of pure breed animals to improve the common stock. Proceedings of the Third Pan-Pacific Science Congress, Tokyo, 1926, p. 1142-1150.

known to many³. We are attempting similar work with the Nagoya chicken of Japan, with the Indian Buffalo, and with our own Philippine chicken.

IMPROVEMENT IN FEEDING METHODS

Any attempt at improvement in local feeding methods should be preceded by an accurate knowledge of the feeding value of feeds used locally. Hence, such commonly known feeds for stock as corn, palay, rice bran, and mungo were studied with this object. The results of these studies have demonstrated clearly the insufficiency or inadequacy of such feeds for the formulation of satisfactory rations. Two outstanding deficiencies in the proper nutrition of Philippine animals were readily recognized. The first



Fig. 3.—Provincial Fair, foundation bull for a draft-beef breed animal for the Philippines. The blood composition is Indian Nellore and Hereford, 50-50 per cent.

lies in the fact that there is too limited a dietary available for Philippine animals, and the second is the absence of reliable sources of animal protein supplements. Efforts, therefore, first centered in studying the possibility of adding locally available materials to our animal dietary. Such feeds as copra meal, snails, shrimps, fish meal, molasses, camote tubers and vines, cassava, pongapong, Guinea grass, Napier grass, sugar cane tops, corn fodder, Japanese or Uba cane, and native pasture grasses, such as cogon, culape, and batadbatadan are occasionally used, but their actual feeding value is unrecognized or not generally appreciated. I would burden you with too much detail were I to review all the work accomplished by the College of Agriculture along the line of feeding. I shall call atten-

³Fronza, F. M., and B. M. Gonzalez. 1927. Developing the Cantonese chicken. *The Philippine Agriculturist* 15: 481-485.

tion, however, to the more important findings from the standpoint of practicability.

We found, for example: That standard rice bran from so called "Cono" mills is from 10 to 25 per cent better in feeding value than corn. That coarse rice bran from so called "Kiskis" rice mills causes a high mortality among pigs and its feeding value is only about one-third that of the "Cono" rice bran.

That copra meal is an excellent ingredient of poultry and swine rations when correctly used, and that the optimum amount to use is about 30 per cent of the ration.

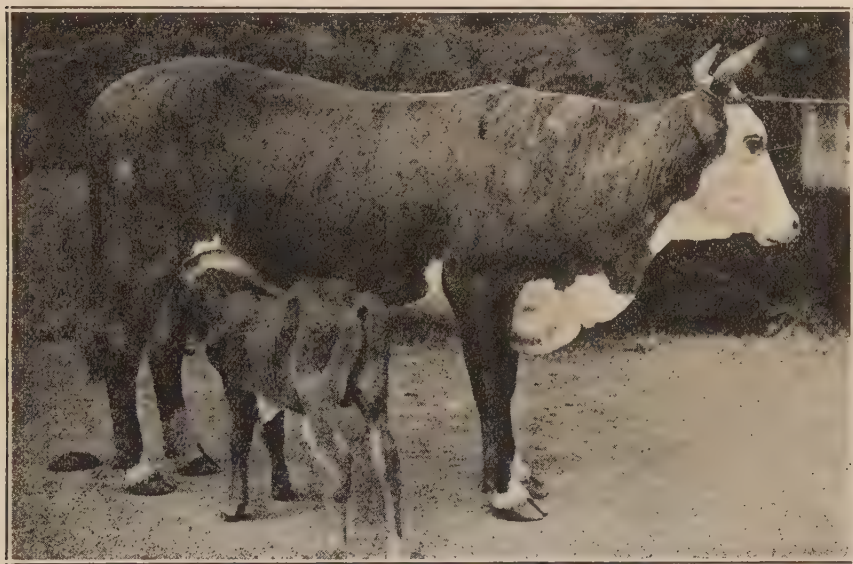


Fig. 4.—Rebecca, one of the foundation cows for a draft-beef breed animal for the Philippines. The blood composition is Hereford 50, Indian Nellore 25, and Philippine 25 per cent.

That cane molasses used in moderate quantities, constituting 20 per cent of the ration of pigs, has a value equal to shelled corn, weight for weight.

That camote, or sweet potatoes is still our best pasture crop for pigs from the standpoint of economy, availability and nutritive value.

That camote tubers and cassava roots have about the same feeding value, and that this ranges from 33 to 50 per cent that of an equal weight of shelled corn, or in other words, from 2 to 3 parts of these roots are equivalent in feeding value to one part shelled corn.

That while pongapong has a feeding value similar to camote and cassava, it is less palatable and swine fed on it grow relatively slower.

That as little as 5 per cent of dried shrimps or fish meal added to a poultry ration practically doubles egg production, and increases profits

two- to three-fold, and that shrimps are as good if not slightly better than tankage and meat meal weight for weight.

That the feeding value of fish meal is almost, but not quite, as good as that of dried shrimps.

That poultry rations devoid of animal protein in some form or another are unsuitable for economical growth and egg production.



Fig. 5.—A Los Baños Cantonese rooster, a locally developed breed improved entirely by selection from the common fowl of Canton, China.

That work cattle turned loose on adequate native pastures need no further supplemental feeding when worked moderately.

That Guinea grass is one of our best forages for work cattle.

That corn fodder preserved in adequately constructed silos may be used the year round in the Philippines, and that even in the hottest weather it need not be consumed faster than similar silage in the United States, or at the rate of two inches deep per day.

That cattle and carabaos will eat silage readily in the Philippines.

That baled rice straw, because it is easily transported, readily available, and cheap, is an excellent supplemental feed for native pastures when they are short during the height of the dry season.

The foregoing constitutes a fair sample of the work we are doing towards animal improvement through feeding.

DISEASE CONTROL

Our approach to the disease problem in our animal improvement program is from the point of view of prophylaxis, or prevention. After presuming an adequate isolation and a well regulated practice of quarantining new additions to the herd, we rest on the supposition that a vigorous



Fig. 6.—A Los Baños Cantonese hen.

well-nourished animal does not fall an easy prey to disease. Hence, the solution of the disease problem lies largely in adequate nutrition. We had an excellent demonstration of this in an experiment with goats and sheep. We kept two lots of these animals composed of as nearly identical individuals as we could make them. One lot was pastured entirely, the other was pastured with the first lot, but in addition this second lot received supplemental grain feeding at night. The degree of infestation in the first lot by intestinal parasites was large, while in the lot receiving additional feed it was practically nil.

Another angle of the disease situation is the inheritance of propensity or susceptibility to disease. We have found, for example, certain in-

dividuals in our horse herd to invariably produce osteoporotic offspring, while other animals kept side by side and given the same feed did not suffer from the ailment.

Any program of animal improvement, therefore, must take into account the elimination of individuals with a known predisposition to a disease. In brief, we attack the disease problem by endeavoring to develop inherently resistant stock, and further promote this resistance by adequate feeding. The relatively low rate of mortality in our herds and flocks is the measure of the degree of success we have attained along this line.

Individual medication and treatment, so necessary at times, we consider as distinctly within the field of veterinary practice.

In brief, this constitutes the animal improvement program of the College of Agriculture. It was formally begun in 1916, although a few individual animals existing in the College herds before that time were drafted into use in so far as they could be made to fit in the program.

B. M. GONZALEZ

Professor of Animal Husbandry and Dean, College of Agriculture

PAPAYA LEAF SPOT¹

F. L. STEVENS AND M. S. CELINO
Of the Department of Plant Pathology

WITH FOUR TEXT FIGURES

A leaf spot of the papaya is very prevalent in the Philippines, often involving enough of the leaf area to interfere with chlorophyll action. The young spots are small, yellowish-brown, water-soaked lesions in the leaves. They appear very clearly as minute transparent areas when viewed against the light. Older spots are circular or nearly so, generally brown with grayish center and surrounded by a yellow colored border about three to four millimeters broad. Large spots are eight millimeters to a centimeter in diameter.

On these spots there is invariably a *Helminthosporium*. On very young spots one-half to one millimeter in diameter there may be only two to ten conidiophores; on old large spots they are very numerous, especially under conditions of humidity. The youngest disease spots discernible, 210 to 345 μ , show no conidiophores, but on being teased apart do show a mycelium identical with that of the *Helminthosporium*.

The *Helminthosporium* is amphigenous but somewhat more abundant on the lower surface. The conidiophores are brown, erect, simple solitary, long, often 600 μ , septate, much constricted and bear a conidium at the end. The cells measure from 20.7 to 151.8 μ in length and vary in thickness from 6 to 7 μ . The conidia are slightly colored, 4- to 9-septate, wide at the basal end to about the middle, and gradually becoming narrow toward the apex. These spores measure from 17.2 to 123 μ in length and from 11 to 21 μ in width.

Also on these spots, usually on the upper surface, there are frequently found clusters of perithecia varying in number from fifty to a hundred or more on a spot nine millimeters in diameter. The spots bearing perithecia are precisely like those bearing the *Helminthosporium* and indeed all spots bearing the perithecia also do bear *Helminthosporium*. The spots with perithecia can, however, often be recognized with the naked eye by the presence of the minute dark brown nearly spherical bodies on the surface. While the *Helminthosporium* occurs on all spots the perithecia occur on less than five per cent of the spots.

¹Experiment Station contribution No. 809. Received for publication December 13, 1930.

The perithecia are of the genus *Mycosphaerella* and the species is clearly of that of *M. caricae* Sydow published in the *Annales Mycologici* vol. 11, p. 403, 1913, the type specimen of which was collected by S. A. Reyes at Los Baños, July, 1913 and sent to Sydow by Dean Charles Fuller Baker.

The leaf spot that we are discussing has been referred to as due to this *Mycosphaerella*² though without the presentation of any evidence as to the causal relation of the *Mycosphaerella* to the leaf spot and with no mention of the presence of the *Helminthosporium*.



Fig. 1.—Photograph of leaf of a young papaya plant atomized with suspension of spores of *Helminthosporium papayae* Syd. when 20 days old showing the leaf spots, also photograph of control leaf showing no spots. Nearly natural size.

Since the *Helminthosporium* was so universally present and the *Mycosphaerella* so rarely, it appeared to us that the *Helminthosporium* was more probably the cause of the disease, unless indeed the *Helminthosporium* and the *Mycosphaerella* are genetically connected, a point which we shall discuss below.

The *Helminthosporium* proved easy of isolation in pure culture on potato dextrose agar. It grows well and spores freely on potato dextrose agar, corn meal, papaya agar, synthetic agar, steamed rice, and potato slice. Not many spores are produced in corn meal agar.

²Reinking, O. A. 1918. Philippine economic-plant diseases. Philippine Jour. Sci. 13:

The growth shown in some culture media is as follows:

1. Potato dextrose agar. Growth is slow, colony grayish white to grayish black, circular with smooth outline, surface much raised and smooth. The medium is colored dark brown.

2. Synthetic agar. Slow growth, circular and fairly thick colony, surface level and smooth, with grayish black center and pale white border. The medium is turned pale yellow.



Fig. 2.—Showing two conidiophores and several conidia of *Helminthosporium papayae* from papaya leaves.

3. Corn meal. Slow growth, raised and circular colony which is grayish white when young and dark when old, surface smooth. The medium is colored black.

4. Steamed rice. Growth is slow, colony is nearly circular with irregular outline, surface is raised and uneven, generally grayish black. The medium is colored dark.

5. Potato slice. Slow growth, circular colony, raised level surface, and uniformly grayish black. The medium is slightly darkened.

6. Papaya agar¹. Growth is thick, dark with raised center, circular with smooth margin.

7. Corn meal agar. Growth slow, colony circular, whitish or gray, center slightly raised.

Suspensions of spores from a pure culture were atomized upon leaves of young papaya plants kept in a moist chamber. About five days after



Fig. 3.—Conidia of *Helminthosporium papayae* from agar culture.

atomizing, spots similar to those occurring naturally appeared. No spots developed on the leaves of the check plants (fig. 1).

The fungus was easily recovered in pure culture by reisolation. Using this culture of the fungus, the experiment was repeated and the disease was produced on the leaves, for the second time. It is thus clearly proved that the *Helminthosporium* is the cause of the leaf spot.

The *Helminthosporium* in question is clearly *H. papayae* Sydow, de-

¹Papaya agar was prepared thus: 200 grams of fresh papaya leaves were boiled, filtered and to the liquid were added 15 grams of agar. The conidia when borne on agar culture are much more slender than when borne on papaya leaves. Compare figures 2 and 3.

scribed in *Annales Mycologici* vol. 21, p. 105, 1923 from material collected by G. M. Reyes at San Ramon Penal Colony, Zamboanga Province, Mindanao, 3, 6, 1921, Bur. Sc. No. 39933.

Several features of especial interest occur in connection with the fungi associated with the papaya leaf spot.

Sphaerella caricae Maublanc⁴ which was regarded by Saccardo⁵ as identical with *M. caricae* Syd. and to which name he gave priority is in description nearly identical with *M. caricae*. We give here the two descriptions in parallel columns, italicizing points of slight difference.

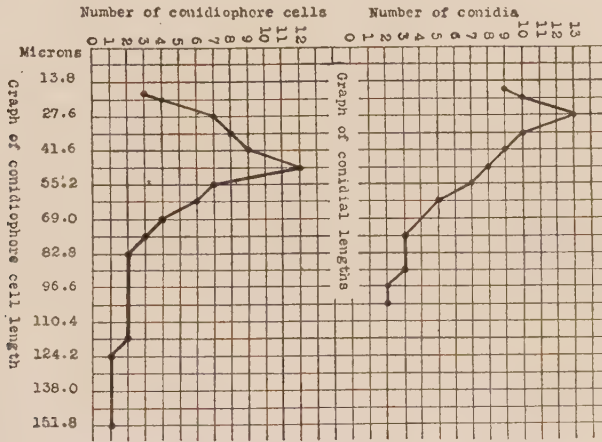


Fig. 4.—Graphs showing lengths of cells of conidiophores and length of the conidia of *Helminthosporium papayae*.

Mycosphaerella caricae Syd.

Maculis amphigenis, orbicularibus, 1/4-1 cm. diam., centro albicantibus; peritheciis epiphyllis, aggregatis, minutis, 70-120 μ diam., pertusis, atris, contextu minute parenchymatico; ascis fasciculatis, clavatis, apice rotundatis, sessilibus, 42-55 9-11 μ , apapophysatis; sporidiis distichis, fusoides, utrinque attenuatis, rectis vel inaequilateris pluriguttulatis, medio 1-septatis, non-constrictis, hyalinis, 16-18 3-1/2-5 μ .

Sphaerella caricae Maub.

Maculis amphigenis, circularibus vel paululum angulosis, 0.5-4 mm. in dia. pallescentibus, dein albicantibus, margine obscuriore cinctis; peritheciis epiphyllous, sparsis, punctiformibus nigris, globulosis, ostiolo papillato donatis; ascis cylindraceutis, interdum apice rotundato-attenuatis, sessilibus 40-50 \times 10-12 μ , apapophysate 8-spored, sporidiis distichis, fusoides, utrinque, obtusiusculis, rectis vel subeuvulvis, 1-septatis, ad septum constrictis, hyalinis, 15-18 \times 3-4 μ loculo superiore leniter inflato.

It may be seen that there is most remarkable agreement extending almost to selection of words and punctuation. The only essential differ-

⁴Bul. Soc. Myc. de France 29: 358, 1913. Pl. 24.

⁵Saccardo P. A. Syll. Fung. 24: 855.

ence is that Sydow specifically states that ascospores are not constricted, while Maublanc states that they are constricted and so figures them.

Examination of local material here shows that when immature the ascospores are not constricted, but that when mature they are exactly as is shown by Maublanc's figures. It seems evident that Sydow saw only immature ascospores. Thus the only essential disagreement between the two descriptions disappears.

Yet constantly associated with the Maublancian *Mycosphaerella* was a conidial form, with ovate two-celled, rough conidia. The association was so intimate that both Maublanc and Saccardo accepted it as evidence that the two were genetically connected though no cultural evidence was adduced.

With *Mycosphaerella caricae* Syd. there is similar though not quite such an intimate association with *Helminthosporium papayae*. Genetic connection between *Helminthosporium* and *Mycosphaerella* is difficult to believe.

All things considered, it appears best for the present to regard *Mycosphaerella caricae* Syd. as synonymous with *Sphaerella caricae* Maub. and to accept Maublanc's conclusion that it possesses a conidial form with two-celled spores; also to regard the association of *Helminthosporium papayae* Syd. with *M. caricae* Syd. as purely accidental, unless cultural evidence to the contrary is adduced.

THE CAUSE OF STERILITY IN SPONDIAS PURPUREA LINN.¹

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WITH FIVE PLATES

It is generally known among our farmers that it is difficult, if not impossible, to propagate sexually our native plum (*Spondias purpurea* Linn.) a cultivated deciduous fruit tree of local importance, introduced from tropical America at an early date by the Spaniards. According to Merrill (1923-1925) this fruit tree is locally known as *sequélas*, *saraguélas*, *sarguélas*, *sereguélas*, *sineguélas*, *siriguélas*, and *sirihuélas*, and perhaps by other names resulting from the corruption of its Spanish name, *ciruela*, a plum.

Its fruit consists of a fleshy exocarp and a hard, stony endocarp enclosing empty cells. In some instances thin, papyraceous, and brownish structures can be found in all of the cells within the stone. These membranaceous structures represent the abortive and degenerated seeds which were not fertilized.

An attempt to germinate a large number of the stones of this fruit tree was made by Morales (1931). Some of the stones were sown without any treatment; others were opened to expose their inside parts. Some were soaked in 5 per cent sulfuric acid and others in 5 per cent potassium hydroxide for one hour and some for thirty minutes. All these treated or untreated stones were planted in seed boxes, and surprisingly enough none of them showed any sign of activity irrespective of the treatments given them prior to planting. This present morphological study of the microsporangium and the megagametophyte of *Spondias purpurea* Linn. was made on account of the possible relation that the structures here studied might have with the failure of this species to set seeds.

MATERIALS AND METHOD²

During the months of February, March, and April, 1931 the material was gathered from trees growing in two localities in Los Baños, Laguna. Flowers and fruits of different sizes and degrees of development were gathered from trees growing in San Antonio-Junction and in the Coconut Grove, and were fixed in the field. Formalin-acetic-alcohol and chromo-acetic stock solution, made according to the formulae given by Chamberlain

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²Thanks are due Mr. Numeriano L. Cuevas, my laboratory assistant, who did the cutting of most of the specimens.

(1924), were used as fixatives. The material was embedded in paraffin, cut 10 microns thick, and stained in Safranin-Delafield's haematoxylin combination and Haidenhain's iron-haematoxylin with a counterstain of orange Gold dissolved in clove oil.

THE FLOWER

The mature flowers of this cauliflorous plant (*Spondias purpurea* Linn.) are borne in fascicles and are rarely solitary, arising from the axils of the fallen deciduous leaves. The individual flower of the inflorescence is subtended by a caducous bract (pl. 1, fig. 5) or in some cases by a number of deciduous bracts (pl. 1, fig. 7). It is reddish in color, rather small, varying from three to three and half millimeters in length, and is borne on jointed pedicel. The calyx of the flower is 4- to 5-lobed, and the petals are from four to five in number, each corolla segment alternating with the calyx lobes. The stamens are ten in number, rarely less, each of which is opposite the perianth (calyx and corolla) segments. The stamens opposite the calyx lobes have longer filaments than those opposite the petals, and all of them are inserted beneath a cupular disk at the base of the pistil. The ovary is sessile, and is almost free, 4- to 5-celled, although three cells are not uncommon (pl. 1, fig. 9). The styles are three to five, and conniving (pl. 1, fig. 8). In each cell is a pendulous ovule, possessing two integuments at its maturity (pl. 4, fig. 18), the micropyle of which is directed towards the stigma (pl. 3, fig. 17).

The inflorescence starts its ontogenetic development as a conical mass of meristematic cells of the bark within the phellogen at the axil of the fallen leaf (pl. 1, fig. 1). This inflorescence initial is usually covered by the overlapping strips of phelloderms, through which it has to elongate. Very early in its development, it cuts off lateral outgrowths, appendages or bracts (pl. 1, fig. 2), and pushes its way through the bark. As soon as this inflorescence initial with the bracts already differentiated has emerged from the bark, floral primordia arise as lateral protuberances from the axils of the lateral bracts (pl. 1, fig. 7).

The first floral organ to develop on the individual floral primordium are the sepals (pl. 1, fig. 3), which arise as a marginal ring of four to five lobes. These calyx lobes grow upward, bend, and cover the floral cone before the other floral members have any time to differentiate. The petals then appear simultaneously (pl. 1, fig. 4), first as mamellate humps within the calyx. These also elongate, bend and enclose the inner floral organs. Later they fuse at their margins (pl. 1, fig. 6-8) as the flower matures. The stamens next develop as a ring of small tubular outgrowths within the whorl of petals (pl. 1, fig. 5-6) and very early differentiate into slender filaments and enlarged microsporangies (pl. 1, fig. 7-8). The last floral organ of the flower to develop is the carpel (pl. 1, fig. 6) of which there are four to five, and rarely three (pl. 1, fig. 9). At maturity of the flower, the petals and

not the calyx cover the essential organs (pl. 1, fig. 8) until the flower opens. The development of the floral organs is, therefore, acropetal, and they arise as follows: sepals, petals, stamens, and carpels. This same sequence of development of the floral organs was also found to be true of *Cocos nucifera* Linn. (Juliano, 1926, and Juliano and Quisumbing, 1931) and *Monochoria vaginalis* (Burm. f.) Presl (Juliano, 1931).

MICROSPORANGE

Very early the stamen differentiates into a slender either long or short filament and an enlarged microsporangium (pl. 1, fig. 7-8). The development of the microsporangium, which is under way long before there is any apparent sign of growth of any of the macrosporangia (pl. 1, fig. 7), is similar to that found in most Angiosperms. The microsporangium is nearly four-lobed (pl. 2, fig. 10a) in transverse section with a central vascular strand becoming apparent as it matures. A row of 4-5 archesporial cells differentiates under each lobe of the microsporangium (pl. 2, fig. 10) and these form a single row equalling the whole length of the microsporangium. By a periclinal division these archesporial cells give rise to an outer layer of primary parietal cells and an inner row of primary sporogenous cells (pl. 2, fig. 10). The primary parietal cells by a periclinal division give rise to an outer layer of parietal cells which divide once or twice forming a rather thin parietal tissue, and an inner layer of tapetal cells (pl. 2, fig. 11).

The primary sporogenous cells produce directly by division a mass of rather large, polygonal microspore mother-cells. These microspore mother-cells contain dense cytoplasm and comparatively large nuclei, somewhat rounded with well defined nuclear membranes (pl. 2, fig. 11). They seem to separate in groups from the surrounding tissues, preparatory to cleavage. Surrounding these microspore mother-cells is the tapetum which is separated from the epidermis by one or two layers of parietal cells. Unlike what we usually find in most Angiosperms, these microspore mother-cells of *Spondias purpurea* Linn. never round off, and their development is arrested. They fail to form the tetrad or microspores. In older microsporangia (pl. 2, fig. 12) where degeneration has set in (pl. 5, fig. 26), these microspore mother-cells lose their dense cytoplasmic contents, their nuclei become small and degenerate. Concomitant with this degeneration of the microspore mother-cells, the tapetum also degenerates and all eventually separate from the parietal tissue (pl. 2, fig. 13). Further degeneration leads to the disappearance of the tapetum and microspore mother-cells as well as a greater portion of the parietal tissue, leaving the loculus hollow and devoid of developed microspores.

In preliminary examinations of mature microsporangia I have found no developed microspores, and this finding is herein confirmed. In Irish potato, degeneration of the sporogenous tissue was also reported by Young

(1923). Here the archesporial cells which function direct as sporogenous tissue, become somewhat shrunken at first, then their cytoplasm stains lightly, and numerous vacuoles appear, while their nuclei assume an abnormal, coarsely granular appearance, especially when unfavorable conditions set in during the development of the bud. The nutritive cells and the tapetum stain but slightly, and appear to have but scanty contents. A little later the sporogenous tissue collapses and passes into a state of disintegration. In some cases when the microspore mother-cells are involved, the cytoplasm shrinks away from the cell wall and appears as an elongated, shriveled mass within the cell, which takes a deep stain. The tapetal cells also collapse and the tissue disintegrates.

Osawa (1913) found occasional degeneration of the microspore mother-cells as well as of the tapetum in *Daphne odora* Thunb., both of which lose their turgor, and their contents stain deeply with safranin and haematoxylin.

Dorsey (1914) observed that in *Vitis* the subsequent division in many microspore mother-cells after they are liberated from the microspore wall is arrested to such an extent that the nucleus does not undergo mitosis. In some cases the microspore wall only partially undergoes the usual thickening and growth and only a slight trace of stainable protoplasm remains.

In *Oenothera lanata* Gates (1907) ascertained that degeneration may take place as early as the microspore mother-celled stage, and to such an extent that the tapetal cells completely disappear, in which case the "middle layer" then grows inward and these fill the cavity of the loculus. In some cases the tetrad may be formed only to break down later owing to lack of nourishment by the tapetum.

In *Coffea arabica*, Faber (1912) observed that 4, 5 or 6 microspore mother-cells may develop in a loculus and that one or more of these may soon degenerate.

In a more mature microsporangium (pl. 2, fig. 13) of *Spondias purpurea* Linn., there are present the epidermal cells, the outer walls of which seem to be somewhat thicker than their lateral walls. Within the epidermis is the enlarged, fairly well differentiated endothelial cells (outermost layer of the parietal tissue), much elongated at right angles to the epidermis, and possessing the scanty characteristic thickenings found in microsporangia of other Angiosperms. This is partly due to the fact that dehiscence is unnecessary inasmuch as no microspores are produced normally in the microsporangia. Enclosed by the epidermis and the endothelial layer is a mass of degenerated, collapsed cells with scanty cytoplasm and their nuclei are scarcely discernible. This degenerated and disintegrated tissue represents the collapsed microspore mother-cells, the tapetum, and a portion of the parietal tissue. In *Spondias purpurea* Linn. the microspore mother-cells have failed to function and consequently no microspores or tetrads

are developed. It is hard to tell whether this degeneration is brought about as a result of heredity or of other physiological disturbances within the microsporangium. One is forced to surmise, as Osawa (1913) did, that such sterilization of the microspore mother-cells might have been brought about by long cultivation and continued asexual propagation as is true of many of the cultivated plants.

A study of the microsporangia of *Spondias cytherea* Sonn. and *S. lutea* Linn., two newly imported species on the College Campus, reveals a very interesting fact. These two species were found by Morales (1931) to be propagated normally by seeds. The microsporangium of *S. cytherea* (pl. 3, fig. 14a; pl. 5, fig. 27) at the time the flower is about to open, is also 4-lobed in transverse section. It is delimited by rather large parenchymatous epidermal cells (pl. 3, fig. 14), within which is the usual endothelial layer. The endothelial cells are devoid of the characteristic thickenings found in *S. purpurea*. Those endothelial cells found far from the stomium are large, and become comparatively smaller as they approach the stomium. The parietal tissue is composed of a single layer of cells which persist only at the portion far from the stomium. These cells possess scanty protoplasm and hardly discernible nuclei. Just lining the partially depleted parietal tissue and the endothelial layer are the large persistent tapetal cells which contain a fair abundance of cytoplasm and distinct nuclei (pl. 3, fig. 15). They are uninucleate and their cytoplasm appears to be undergoing degeneration. Within the loculus are the large microspores (pl. 3, fig. 14-14a; pl. 5, fig. 27).

The microsporangium of *S. lutea* also at the time the flower is about to open is 4-lobed in transverse section (pl. 3, fig. 16a; pl. 5, fig. 28). It is surrounded by irregular, parenchymatous epidermal cells, within which are the large endothelial cells with thick rod-shaped thickenings (pl. 3, fig. 16). The tapetum has already undergone degeneration and only a portion of the remains of the depleted parietal tissue still persists. The microspores are quite abundant, and are much larger than those of *S. cytherea* (pl. 5, fig. 27). The fact that microspores are formed in *S. cytherea* and *S. lutea*, and that their seeds are viable and readily respond to cultural methods (Morales, 1931) simply indicates that normal pollination and fertilization take place in the production of such germinable seeds. Whereas in *S. purpurea* where we find complete sterilization of the potential microspore mother-cells which consequently fail to produce microspores, the possibility of pollination and subsequent fertilization of the megagametes is very remote. This may account for the failure of the macrosporangia to develop into normal seeds. Since fertilization is not attainable in view of the foregoing circumstances, the development of the fruit is a clear case of parthenocarpy.

MACROSPORANGE AND MEGAGAMETOPHYTE

At the time the microsporangies are in the microspore mother-celled stage, the macrosporangies have already emerged from the placental wall of the individual carpel (one in each carpel) as rounded protuberances which are at first directed laterally (pl. 1, fig. 8). Each of these protuberances forms the nucellus of the nascent macrosporangium. This juvenile macrosporangium then grows downward, and its two integuments are fully developed by the time the megaspore mother-cell is clearly differentiated (pl. 4, fig. 18). The macrosporangium by one-sided growth first directs its micropyle towards the axil of the ovary (pl. 4, fig. 18), and later towards the stigma (pl. 3, fig. 17), especially at its maturity.

A single archesporial cell differentiates from the nucellus at the time the two integuments have been formed. By a periclinal wall this archesporial cell forms an outer primary parietal cell and an inner primary sporogenous cell. The primary parietal cell divides periclinally (pl. 4, fig. 19) and together with the adjacent nucellar cells forms a very thick nucellar tissue pushing the gametophyte way deep in the nucellus. This is clearly shown at the time the four daughter megaspores are developed (pl. 4, fig. 20).

The sporogenous cell or the megaspore mother-cell is at first polygonal in shape, then it elongates (pl. 4, fig. 19) before passing into the synaptic stage. This megaspore mother-cell contains a dense cytoplasm, and a very much enlarged rounded nucleus. By two successive divisions, this megaspore mother-cell gives rise to a linear tetrad of four megaspore daughter cells (pl. 4, fig. 20), the lowermost of which becomes functional (pl. 4, fig. 21). The chalazal megaspore daughter cell then elongates, and forms large vacuoles at its extremities, and its nucleus assumes a central position. Here its nucleus divides into two (pl. 4, fig. 22), the two daughter nuclei migrating separately towards the poles (pl. 4, fig. 23). By two successive divisions an eight-nucleate megagametophyte is formed, (pl. 4, fig. 24-25), similar to that of *Rhus toxicodendron* (Grimm, 1912).

The oldest megagametophyte I was able to obtain is that shown in plate 4, figure 25. The egg-apparatus which consists of a megagamete and two synergids, is well developed. The synergids are pyriform in shape, possessing distinct nuclei and devoid of the "filiform apparatus" found in *Lyonothamnus floribundus* (Juliano, 1931). One of the synergids has already the beginnings of the formation of a vacuole. The megagamete which lies behind the two synergids has a large basal vacuole and dense cytoplasmic contents at its apex. The nucleus is comparatively larger than those of the synergids.

The polar nuclei which lie at one side of the megagametophyte are about to fuse.

The antipodals have no distinct cell walls; they seem to be undergoing degeneration. These are, therefore, ephemeral in nature. In *Spondias purpurea* we then have a megagametophyte which is normal, possessing a potential megagamete and polar nuclei much needed for the normal development of the seed, while its microgametophyte is sterile. This opens up a possibility of pollinating the pistil of *S. purpurea* with the microspore from either *S. cytherea* or *S. lutea*, results of which will be of great interest to us. From such work will naturally evolve the possibility of producing a species perhaps much superior to our *S. purpurea* with the desirable characters of either *S. cytherea* or *S. lutea*, depending on the objectives of the breeder.

By casual observation, one is apt to attribute the failure of *Spondias purpurea* to set seeds to the development of a hard, stony layer, derived from the inner portion or endocarp of the pericarp wall. This is far from being the truth. In green fruits where the stony layer is still soft and not lignified, there is present in each locule a seed-like whitish structure. On microscopical examination this seed-like structure was found to possess distinct coats within which are large parenchymatous cells devoid of cytoplasmic contents. There is no sign of development of any embryo. These partially developed ovules with stimulated growth are the ones which become the brownish, membranaceous structures within the cells of the mature stone.

SUMMARY

The fascicled inflorescence arises as a rounded protuberance of the bark within the phellogen, and very early cuts off bracts before it emerges from the bark. As soon as the inflorescence initial has emerged from the bark, lateral protuberances (floral primordia) are formed simultaneously at the axils of the bracts.

The development of the floral organs is acropetal, and these arise as follows: sepals, petals, stamens, and carpels.

The stamen very early differentiates the microsporangium (anther) and the filament. A plate of four to five archesporial cells is formed, and these cells divide periclinally forming the primary parietal layer and the primary sporogenous cells. The primary parietal layer gives rise to a parietal tissue of three to four layers of cells, the outermost layer of which becomes the endothecium, while the innermost layer functions as the tapetum. The primary sporogenous cells by repeated divisions give rise to a mass of microspore mother-cells. These microspore mother-cells together with the tapetum and the parietal tissue degenerate so that at maturity of the microsporangium none of these structures remains except the epidermis, endothecial layer, and a portion of the remains of the parietal tissue. No microspores (pollen grains) are formed.

In *S. cytherea* Sonn. and *S. lutea* Linn. which produce seeds normally, microspores (pollen grains) are formed in their microsporangies.

The microsporangium of *S. purpurea* Linn. develops at the time the microspore mother-celled stage. A normal seven-celled megagametophyte is formed. The egg-apparatus as well as the polar nuclei are strongly developed, while the antipodals are ephemeral in nature.

No seed is formed in the mature stone and this apparent sterility of *S. purpurea* Linn. is due in part, if not wholly, to the degeneration of the microspore mother-cells, and not at all to the megagametophyte which is normal.

This sterile condition of the microsporangies of *S. purpurea* may need the use of microspores (pollen grains) from the two other species, *S. cytherea* and *S. lutea*, in an attempt to force our native plum to produce fertile and viable seeds.

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EXPLANATION OF THE PLATES

The photomicrographs were made in the Bureau of Science, Manila.

Parts of the inflorescence and the flower are designated as follows: antipodals (*an*), bark (*b*), bract (*bt*), carpels (*c*), endothecium (*en*), inner integument (*ii*), megagamete (*mg*), microspores (*mi*), nucellus (*n*), outer integument (*ot*), ovary wall (*ow*), petals (*p*), parietal cells (*pc*), polar nuclei (*pn*), sepals (*s*), stamens (*st*), synergids (*sy*), tapetum (*t*).

PLATE I. *Spondias purpurea* Linn.

- Fig. 1. Transverse section of the bark at the axil of fallen leaf showing the inflorescence primordium. $\times 47$.
 Fig. 2. A much older inflorescence primordium with the bracts already differentiated. $\times 47$.
 Fig. 3. Longitudinal section of a floral primordium showing the calyx lobes already developed. $\times 28$.
 Fig. 4. An older floral primordium showing the beginnings of the petals. $\times 28$.
 Fig. 5. A still older floral primordium showing the sepals, petals, and stamens. $\times 28$.
 Fig. 6. A very old floral primordium with all its parts fully differentiated. $\times 28$.
 Fig. 7. Longitudinal section of an inflorescence showing much more developed condition of the terminal floral primordium than the lateral primordia. $\times 28$.
 Fig. 8. A longitudinal section of the flower with all its parts fully developed. $\times 47$.
 Fig. 9. Transverse section of the ovary showing development of three carpels within each of which is a single microsporangium (shaded). $\times 28$.

PLATE II. *Spondias purpurea* Linn.

- Fig. 10. Portion of a transverse section of a young microsporangium showing archesporial cells dividing into outer primary parietal cells and inner primary sporogenous cells. $\times 1060$.
 Fig. 10a. Diagram of the same microsporangium. $\times 53$.
 Fig. 11. Portion of a longitudinal section of young microsporangium showing the microspore mother-cells, tapetum, and the parietal cells. $\times 890$.
 Fig. 12. Portion of a transverse section of an older microsporangium where degeneration has set in. Note the developed endothelial layer, and the degeneration of the microspore mother-cells and the tapetum. $\times 410$.
 Fig. 13. Portion of a transverse section of a microsporangium of a flower about to open showing more advanced degeneration of the microspore mother-cells and the tapetum. $\times 410$.

PLATE III. *Spondias cytherea* Sonn.

S. lutea Linn., and *S. purpurea* Linn.

- Fig. 14. Portion of the transverse section of a microsporangium from a flower of *Spondias cytherea* showing microspores. $\times 410$.
 Fig. 14a. Diagram of the same microsporangium. $\times 47$.
 Fig. 15. Tapetal cells much enlarged. $\times 1060$.
 Fig. 16. Portion of the transverse section of a microsporangium from a flower of *Spondias lutea* showing microspores. $\times 410$.
 Fig. 16a. Diagram of the same microsporangium. $\times 47$.
 Fig. 17. Diagram of a longitudinal section of the pistil of *Spondias purpurea* showing the position of the mature macrosporangium. $\times 27$.

PLATE IV. *Spondias purpurea* Linn.

- Fig. 18. Diagram of a longitudinal section of a macrosporangium with integuments fully differentiated. $\times 490$.

- Fig. 19. Portion of the nucellus (from fig. 18) showing megaspore mother-cell at a resting stage, and the two layers of cells of the parietal tissue. $\times 1060$.
- Fig. 20. Tetrad. Note the thick parietal tissue derived from the primary parietal cell and the adjoining nucellar cells. $\times 540$.
- Fig. 21. Tetrad, chalazal megaspore enlarging. $\times 890$.
- Fig. 22. Bi-nucleate megagametophyte. Note the central position of the two daughter nuclei. $\times 1060$.
- Fig. 23. Bi-nucleate megagametophyte showing polarity. $\times 1060$.
- Fig. 24. Quadri-nucleate megagametophyte. $\times 1060$.
- Fig. 25. Nearly mature megagametophyte; note the degeneration of the antipodals. $\times 1060$.

PLATE V. *Spondias purpurea* Linn., *S. cytherea* Sonn. and *S. lutea* Linn.

- Fig. 26. Portion of the transverse section of a microsporangium of *S. purpurea* Linn. showing the degeneration of the sporogenous tissue. $\times 416$.
- Fig. 27. Portion of a transverse section of the opened flower of *S. cytherea* Sonn. showing microsporangies with developed microspores. $\times 200$.
- Fig. 28. Portion of a transverse section of the opened flower of *S. lutea* Linn. showing microsporangies with developed microspores. $\times 200$.

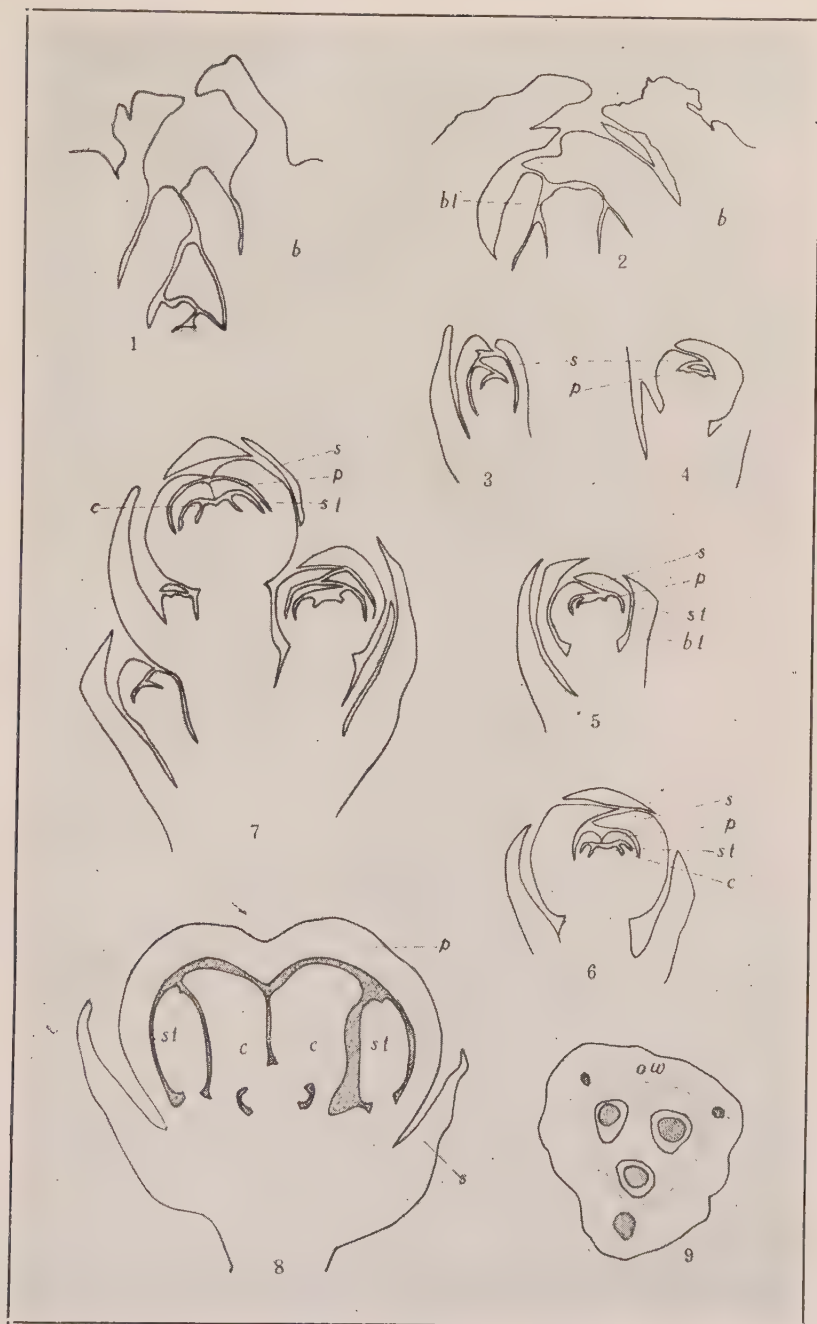


Plate I

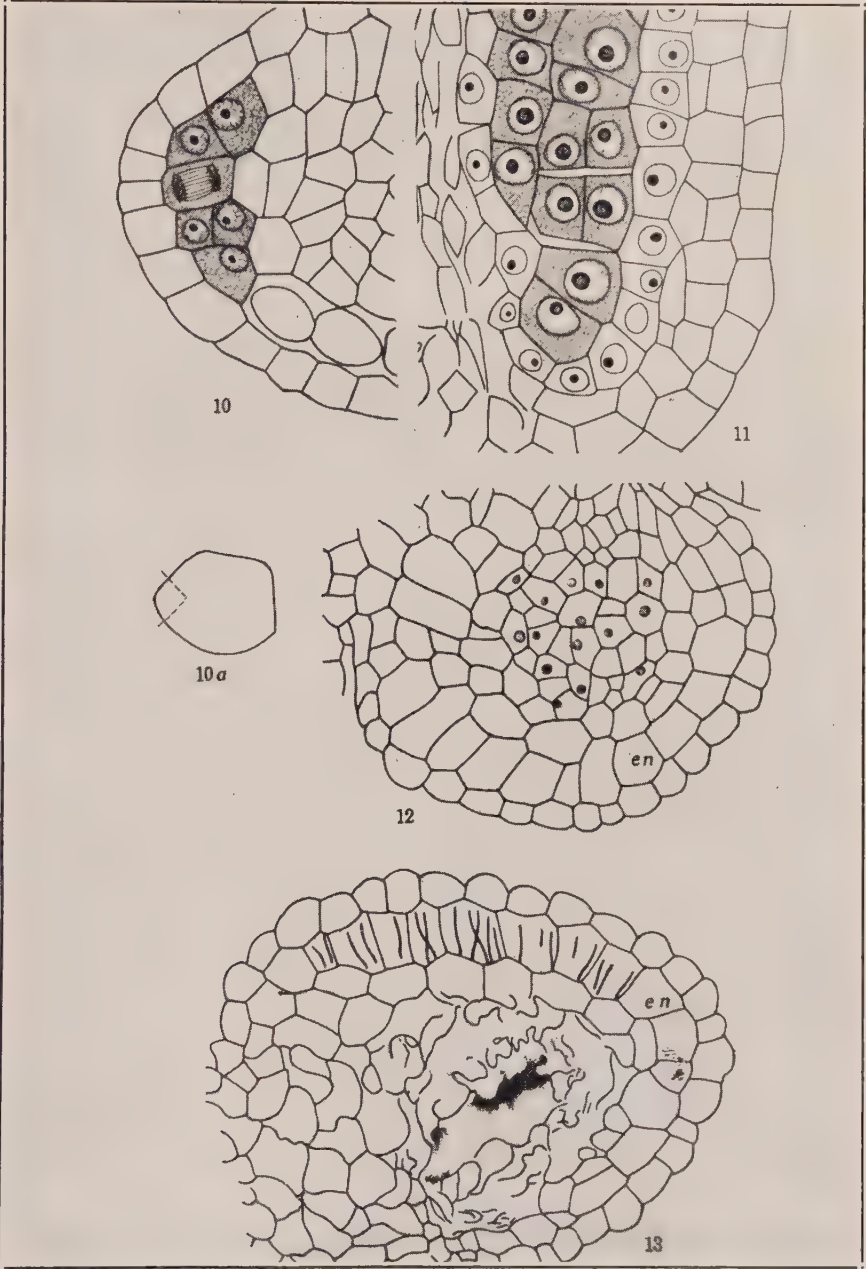


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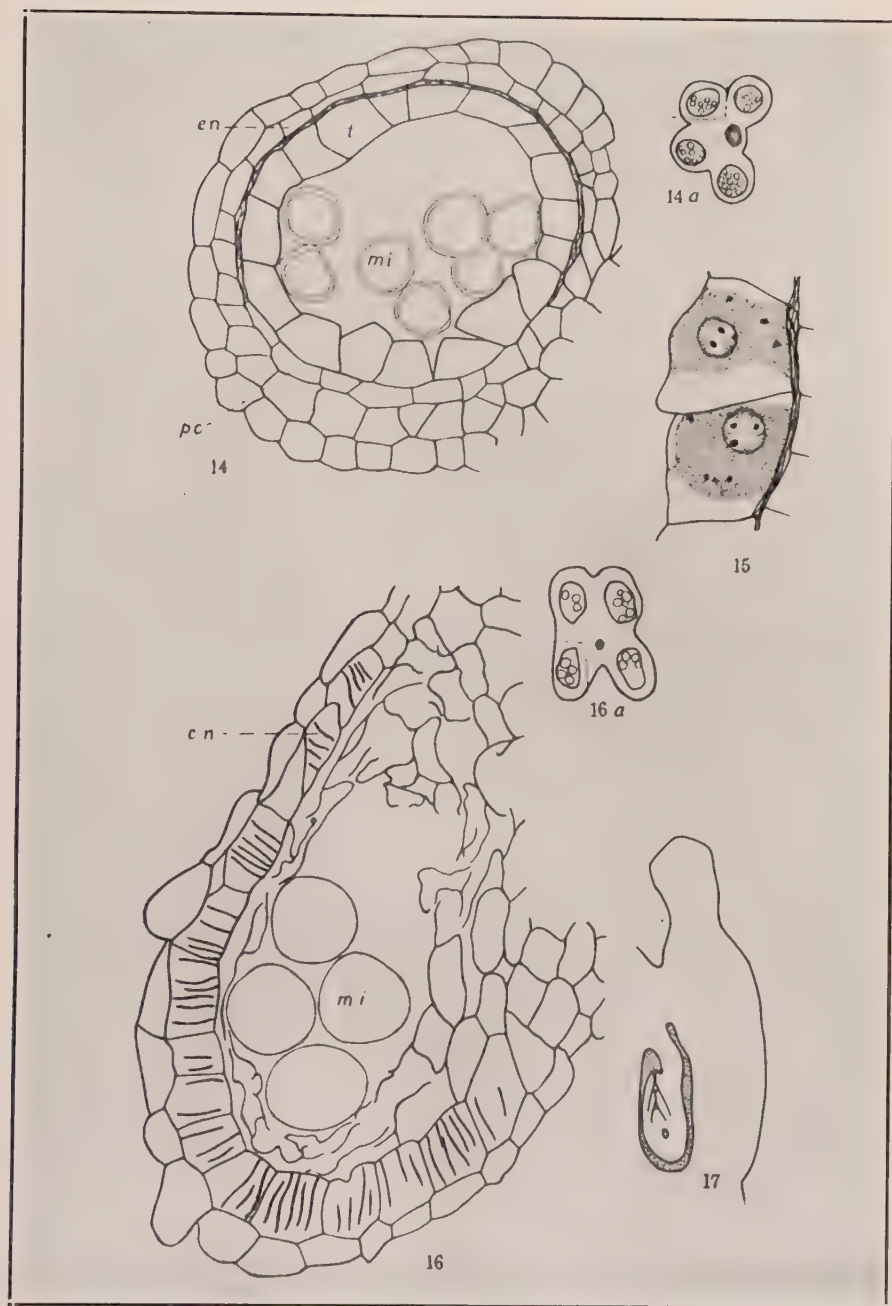


Plate III

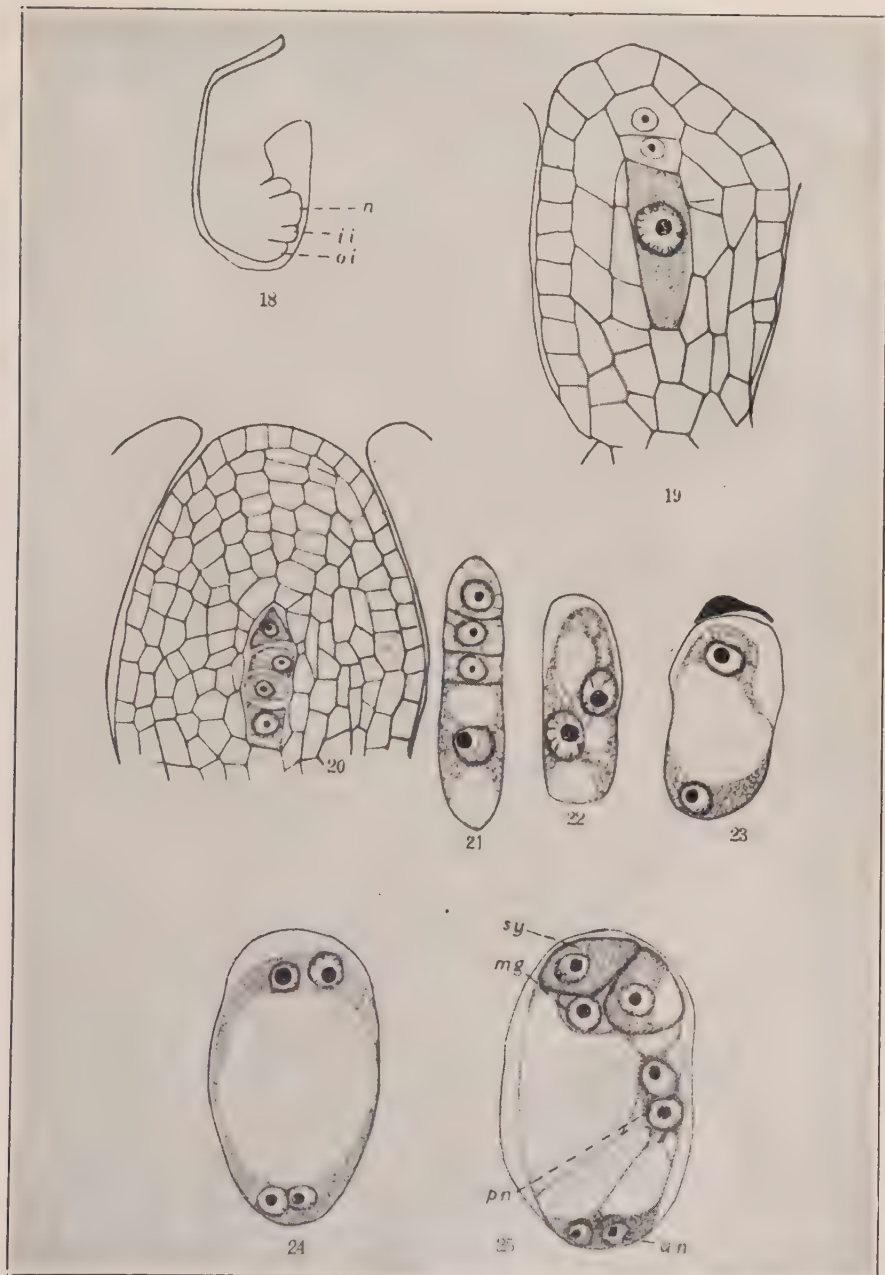


Plate IV

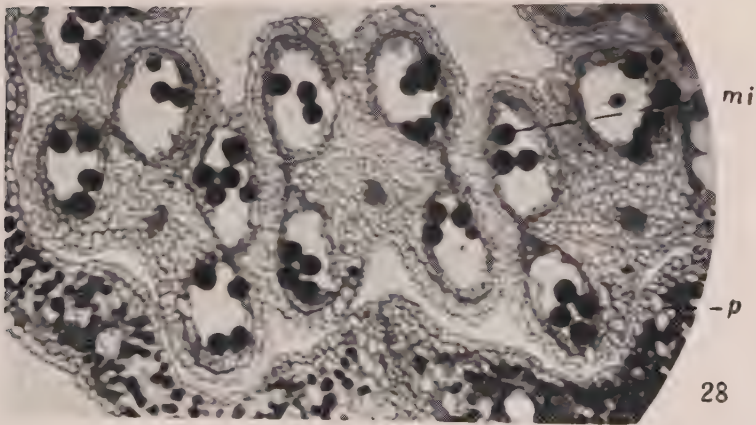
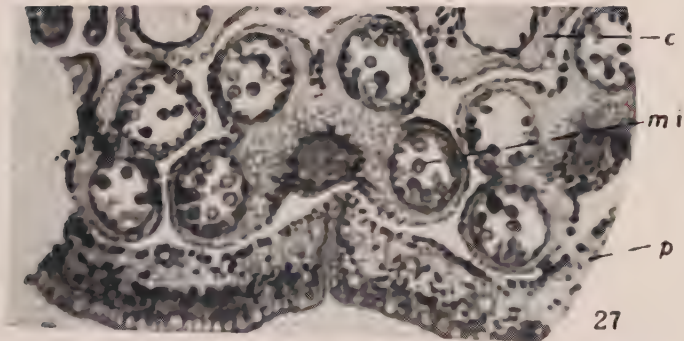


Plate V

A LIST OF PLANTS USED IN CONNECTION WITH FISHING
ACTIVITIES IN THE LAGUNA DE BAY REGIONS AND IN
BATANGAS PROVINCE, LUZON¹

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In the course of our field work in Laguna de Bay regions and in Batangas Province, we became interested in the ways native plants are used in connection with the fishing activities in the regions covered. For the information of those interested in the subject we here present a list of such plants and their local distribution, together with notes on the methods of preparation of the portions of the plants utilized.

TYING MATERIALS

1. *Ichnocarpus volubilis* (Lour.) Merr. Apocynaceae. Common names: hinggiu; seguid.

Rather abundant in almost all parts of the Philippines.

The vines are gathered and cleaned. They are then bundled together, each bundle containing from 500 to 1,000 vines. They are allowed to dry in the air for a few days; and are then soaked in water for from one to two days before using.

This is the most common species of vine used as tying material in making the *baklad* (fish corral). The vine is also used for tying the *bombon* and other similar fishing devices and traps.

2. *Streptocaulon baumii* Decne. Asclepiadaceae. Common names: hinggiu-na-puti; itiban (Batangas).

Found in thickets and secondary forests. Rather scarce in Laguna de Bay regions, but common in Batangas Province.

The vines do not need special treatment. After cutting them into convenient lengths, they are dried in the air; then soaked in water for a few hours before using.

Itiban is principally used in Batangas for making ropes employed in the operation of large *pukot* (drag seines) in salt water. Said to be very durable in water.

3. *Agelaea trinervis* (Llanos) Merr. Connaraceae. Common names: kamagsa (northern Luzon); ulali or tayabak (Tagalog).

Found in forests at low and medium altitudes. Quite abundant in the regions about Paete, Laguna Province, where large quantities are gathered to supply the demand in Laguna de Bay regions.

Principally used as tying materials for the *baklad* in the regions about Talim Island (Laguna de Bay) where this vine is considered superior to *Ichnocarpus volubilis* (see above). Said to be very durable in fresh water and is known to withstand stormy weather.

¹Experiment Station contribution No. 811. Received for publication August 28, 1931.

4. *Rourea volubilis* (Blanco) Merr. Connaraceae. Common names: kamagsa; kamagsa-takilis.

Found in the thickets and forests at low and medium altitudes.

Commonly used as tying materials in making the *takilis*, a sort of *baklad* (corral) device used in catching dalag, *Ophicephalus striatus* Bloch, hito, *Clarias batrachus* (Bloch), tinikan, *Anabas testudineus* (Bloch), and other fishes in Laguna de Bay.

5. *Rourea erecta* (Blanco) Merr. Connaraceae. Common name: kamagsa.

Found in close association with *R. volubilis*. This and the foregoing species of kamagsa are very similar, differing only in the form of the leaves.

It is utilized in the same way as *R. volubilis*.

6. *Quisqualis indica* Linn. Combretaceae. Common names: tafigolo; tag-arau.

Widely distributed in thickets and secondary forests at low and medium altitudes. Rather common in the forests of Batangas Province.

Used as tying materials in holding the *bubô* (basket trap) in the water. These are not the same *bubô* as those found in Laguna de Bay. They are huge basket traps used for catching deep-sea fishes in the waters bordering the coast of Batangas Province. This vine is said to be very durable in salt water.

7. *Combretum squamosum* Roxb. Combretaceae. Common names: malatumbaga; tag-arau.

Found in close association with *Quisqualis indica* and is used in Batangas Province for tying materials in basket traps.

8. *Aspidopteris elliptica* (Blume). A. Juss. Malpighiaceae. Common names: tauag-amo; tauag-ama.

Found in thickets and second growth forests at low and medium altitudes, principally in the island of Luzon. Quite abundant in the Mount Maquiling region.

Used as tying materials in making fish corrals, but its use is not as general as that of hingsu, *Ichnocarpus volubilis*. Said to be very durable in fresh water.

9. *Stenochlaena palustris* (Burm.) Bedd. Polypodiaceae. Common names: hagnaya; diliman.

Rather common in the regions about Cavinti and Paete, Laguna Province, where it is gathered in commercial quantities. Most of the men engaged in the business of selling hagnaya are located in Pagsanjan, and Lumbang, Laguna.

Unlike the tying materials named above, hagnaya is not a vine but a species of fern. The stems of this fern are utilized as tying materials in the making of the lighter portions of the *baklad*, such as the *pabahay* and the *kulong*. The Hagnaya is especially used by the *baklad* fishermen in and around Calamba, Laguna, in place of *yunot* (see *Arenga pinnata*).

10. *Rhaphidophora merrillii* Engl. Araceae. Common names: lokmoi; tibatib.

Of wide distribution in the Philippines. Found in abundance in thickets and forests at low and medium altitudes.

The woody portions of the aerial roots of this creeping vine on trees are much used as tying materials in the making of baskets, chairs, lamps, and a great many other domestic articles. It is also used in the making of fancy fish baskets and traps. In the province of Batangas the roots of this plant are made into ropes that are used in tying anchors of fishing boats operated in deep waters of the sea. Said to be very durable in salt water.

11. *Arenga pinnata* (Wurmb) Merr. Palmae. Common names: cabonagro; kaong.

Found in primary and second growth vegetation and in almost all cultivated areas in the Philippines. Planted occasionally for its fruit and sap which are used for local consumption.

The fibers which are taken from the leaf sheaths of this palm are made into ropes locally known as *yunot*. These ropes are extensively used as tying materials in the making of lighter portions of the *baklad* (fish corral) such as the *pabahay* and the *kulong*. This

fiber is especially used by the *baklad* fishermen of Mayondon, Los Baños, Laguna. The *yunot* is used in a great many other ways in connection with fishing in the Philippines.

12. *Calamus halconensis* Becc. Palmae. Common name: lambutan.

Found in primary forests of medium altitudes especially in the province of Laguna and in the island of Mindoro. Found in abundance in the forests of Mount Maquiling and of Mount Lobo, Batangas.

The stems of this rattan are split into pieces of convenient lengths and used in making baskets and fish traps, such as *bucalot*, which are used for trapping spawning dalag in Laguna de Bay. It is also used for tying together pieces of bamboo splits for making fish traps such as the *salakab* employed in shallow waters in Laguna de Bay.

13. *Calamus maximus* Blanco. Palmae. Common name: palasan.

Very abundant on Mount Maquiling and the regions about Paete, Laguna.

The barbs on the flagella of this palm are used for hooks in catching eels, especially the river eel, *Anguilla mauritiana* Bennett, locally known as palos, or igat.

14. *Calamus mindorensis* Becc. Palmae. Common name: tumalim.

Found in close association with *C. halconensis*.

This rattan is principally used for making baskets, beds, and other domestic articles. It is used sparingly as tying materials in making fish traps.

15. *Calamus siphonospathus* Mart. Palmae. Common name: biri.

Very abundant on Mount Maquiling. Used for same purposes as *C. halconensis*.

16. *Calamus usitatus* Blanco. Palmae. Common name: tandulang parang.

Widely distributed in the Philippines. Especially found in abundance in secondary forests and thickets at low and medium altitudes. Plentiful on Mount Maquiling along edges of cultivated lands.

This rattan is extensively used for tying *salakab*, in making *bukatot*, and also fish baskets used on Laguna de Bay.

17. *Daemonorops mollis* (Blanco) Merr. Palmae. Common name: ditan.

Widely distributed in low and medium altitudes. Found in abundance in all forests in Laguna and Batangas.

Used in the same way as *C. halconensis*.

18. *Daemonorops ochrolepis* Becc. Palmae. Common name: sumulid.

Distribution and use much the same as *D. mollis*

MATERIALS FOR A BOMBON

There are two kinds of *bombon*: that which is used to trap prawns and that which is used to trap large fish, such as dalag, *Ophicephalus striatus* Bloch, hitô, *Clarias batrachus* (Bloch), tinikan, *Anabas testudineus* (Bloch), and other fishes in the shallow waters of Laguna de Bay.

The *bombons* for catching prawns are shrubs bunched together and allowed to dry until all the leaves fall off. Then the shrubs are submerged in water a few decimeters below the surface. From time to time they are lifted up while dip nets are carefully set below to collect the prawns that have been attracted to the traps. The most common species of prawns taken in this *bombon* is *Palaemon lanceifrons* Dana.

The *bombons* for trapping the large fish are made of branches of trees bunched together, placed in certain portions of the lake, and allowed to remain there for certain periods of time, sometimes for months. They are then surrounded by *baklad* locally known as the *takilis* and the branches

are removed. The fish which may be in hiding are frightened out of the *bombon* and caught in the corral by means of *salakab*, the hands, or dip nets.

The following plants are used for making *bombon* for catching prawns:

1. *Flemingia strobilifera* (Linn.) R. Br. Leguminosae. Common names: payang-payang; tabang-bayauak.

Widely distributed in the Philippines; found in abundance in settled areas, open dry waste places, pasture lands, *cogonals*, and second growth forests. Used to be plentiful in open waste areas along the shores of Laguna de Bay, but because of the large demand for it for making *bombon* the plant is rapidly disappearing.

2. *Desmodium gangeticum* (Linn.) DC. Leguminosae. Common names: mangkit; dikit-dikit; payang-payang (not *Flemingia strobilifera*).

Found in habitats similar to that of *F. strobilifera*. This plant is found wild in large patches along the shores of Laguna de Bay. This shrub is much used in Laguna de Bay.

3. *Desmodium laxiflorum* DC. Leguminosae. Common name: mangkit-labuio.

Very similar to mangkit, *Desmodium gangeticum*.

4. *Sesbania cannabina* (Retz.) Pers. Leguminosae. Common name: balakbak.

This shrub is quite common in the Philippines and like the mangkit, great patches may be found along the sandy shores of Laguna de Bay.

5. *Callicarpa cana* Linn. Verbenaceae. Common names: tigau; lalis; tubang-dalag.

Rather common in thickets and second growth forests at low altitudes.

6. *Callicarpa formosana* Rolfe. Verbenaceae. Common names: tigau; palis; tubang-dalag; timbabasi; tubaybasi.

Commonly mistaken for *C. cana*.

7. *Stachytarpheta jamaicensis* (Linn.) Vahl. Verbenaceae. Common names: kandikandilaan; hinlalayon (Batangas).

A very common weed in open waste places at low and medium altitudes. Quite common along the shores of Laguna de Bay, and along the seashore and dried river beds in Batangas Province.

8. *Tabernaemontana pandacaqui* Poir. Apocynaceae. Common names: kampupot (Batangas); pandakaki.

Very common in thickets at low altitudes. Often large patches are found near seashores and lakeshores.

9. *Sida acuta* Burm. f. Malvaceae. Common names: escoba; ualisualisan.

Dominant weed in open waste places. Large patches are not uncommon along the shores of Laguna de Bay, and in the edges or borders of cultivated areas in Batangas Province.

10. *Murraya paniculata* (Linn.) Jack. Rutaceae. Common name: kamuning.

Widely distributed in the Philippines, sometimes cultivated for ornamental purposes. This is a small, many-branched tree which makes it a very good material for making *bombon*.

Branches of trees enumerated below are used for making *bombon* for catching fish, such as dalag, hito, tinikan and other species:

1. *Bauhinia malabarica* Roxb. Leguminosae. Common names: alibangbang; alam-bangbang.

Very common on open dry slopes of the Philippines. Rather common along edges or borders of cultivated areas.

2. *Tamarindus indica* Linn. Leguminosae. Common name: sampalok.

Cultivated in settled areas.

As this tree is of economic value it is not much used for making *bombon*.

3. *Leucaena glauca* (Linn.) Benth. Leguminosae. Common names: Santa Elena; ipilpil; Jerusalem.

Very common in open and second-growth forests at low and medium altitudes.

4. *Streblus asper* Lour. Moraceae. Common name: kalios.

Rather common in thickets at low altitudes. Not uncommon along borders of open, cultivated areas.

5. *Ficus balete* Merr. Moraceae. Common name: balete.

Common in forests at low and medium altitudes. Not uncommon in rocky places along the shores of Laguna de Bay as well on islands in the lake. It is also common along rocky mountain sides on the sea coast of Batangas Province. In Batangas the branches of this tree are seldom used for making *bombon*.

6. *Cordia dichotoma* Forst. f. Boraginaceae. Common name: anonang.

Widely distributed in the Philippines. In Laguna and in Batangas this tree is common in open places near settled and cultivated areas. It is not uncommon to find this tree along boundaries of cultivated fields.

7. *Psidium guajava* Linn. Myrtaceae. Common names: bayabas; guava.

Widely distributed in the Islands, often found in large patches in open settled areas as an escape from cultivation.

8. *Breynia cernua* (Poir.) Muell.-Arg. Euphorbiaceae. Common names: matang-hipon; matang-ulang.

Distribution and use similar to that of *Cordia dichotoma*, anonang (No. 6, above).

9. *Flüggea virosa* (Roxb.) Baill. Euphorbiaceae. Common names: bayasit; boiset; sorot-daga.

Distribution and use same as for *C. dichotoma*.

10. *Mallotus philippensis* (Lam.) Muell.-Arg. Euphorbiaceae. Common name: बनато.

Distribution same as *Flüggea virosa*.

FISH POISONS

1. *Barringtonia asiatica* (Linn.) Kurz. Lecythidaceae. Common name: botong (Tagalog, Bicol).

Medium-sized tree of wide distribution on and near the sandy beaches of Batangas Province. Found also near the barrio of Uaua, Bay, Laguna Province.

The bark which is reddish-grey is used for poisoning fish. A sufficient quantity of bark, preferably taken from a mature tree, is cut into small pieces, which are then comminuted and mixed with earth in a wooden mortar. The proportion is about one part of earth to three parts of bark. The quantity of bark to be used depends upon the size of pond to be poisoned.

The mixture is put in a gunny sack; a half-sack full has been found by experience to be sufficiently strong to kill fish in a pond of about a meter deep and eight meters in diameter. The time of application of the fish poison has been found to be most satisfactory at early dawn; then by six or seven o'clock in the morning the stunned fish may be collected from the pool thus treated.

2. *Diospyros multiflora* Blanco. Ebenaceae. Common names: kanomoi; kanomi (Tagalog)

A tree of medium size of wide distribution in the forests of Mount Lobo, Batangas Province. It grows also in the open land. Only a few specimens are found growing on Mount Maquiling and these are on dry and rocky spots.

The fruit of this tree is used as fish poison; it may be prepared as follows: Fruit, preferably collected at the time when it is just showing indication of ripening, is pounded in a wooden mortar and mixed with a small quantity of soil. Care must be taken in handling the fruit as the juice is corrosive and may burn the skin.

Experience has shown that a petroleum can of powdered fruit is sufficient to kill fish in a pool or pond about twenty square meters in area and about two to three meters deep. The application of the poison may be at about six o'clock. This poison has been found to be more effective in fresh water than in salt water.

3. *Gardenia curranii* Merr. Rubiaceae. Common names: bayag-usa (Batangas); malarayap, malasampaga (Tagalog regions).

A tree of comparatively small size of wide distribution in rocky and dry forests on Mount Lobo, Batangas, Absent, or at least very rare, on Mount Maquiling.

The fruit is used as a fish poison. The method of preparation is as follows: the ripe fruit is powdered with earth in a wooden mortar. About a petroleum can of the powdered fruit is effective used in a pool of water about a meter deep and ten meters wide.

This poison has been found to be more effective in fresh water than in salt water. The time of application, according to experienced users, is about five to six o'clock in the morning. The poison is said to take effect within an hour after application.

4. *Callicarpa cana* Linn. Verbenaceae. Common names: tigau (Visayan, Bicol, Tagalog); tambalasi (Tagalog); tubang-dalag or palis (Lobo, Batangas and in Los Baños, Laguna.).

A shrub which grows in large patches in the parang (cogonal) of the Philippines. Abundant in Lobo, Batangas, and in open places about the regions of Mount Maquiling.

Branches are used for making *bombon* for catching prawns in Laguna de Bay, and the leaves are used as fish poison. The leaves are prepared as fish poison by pounding them with earth in a wooden mortar until they become powder-like in appearance. When the leaves become juicy, the mixture is ready for use. A ganta of such mixture will be strong enough to stun or even kill the fish in a pool of about one meter deep and five meters wide.

The poison may be applied at any time of the day, but five or six o'clock in the morning is the usual time of application. The poison takes effect within an hour after application.

5. *Callicarpa erioclona* Schauer. Verbenaceae. Common names: palis (Tagalog); tambalabasi (Tagalog); tigau (Tagalog, Visayan); tubang-dalag (Tagalog).

A shrub of wide distribution from Cagayan to Sorsogon. It is found in primary forests at low altitudes on Mount Maquiling.

The method of preparation and its application as a fish poison is similar to that of *Callicarpa cana*.

6. *Callicarpa formosana* Rolfe. Verbenaceae. Common names: palis (Tagalog); tambalabasi (Tagalog, Visayan, Bicol); tubang-dalag (Tagalog).

A shrub of wide distribution in the Philippines. In Los Baños, Laguna and vicinity, it is found growing in open places and along boundaries of cultivated lands.

The branches are used for making *bombon* for catching prawns in Laguna de Bay, and the leaves are used as fish poison. The method of preparation of the leaves as fish poison and its application is similar to that of *C. cana*.

7. *Tinomiscium philippinense* Miers. Menispermaceae. Common names: lag-tang; libtang (Tagalog).

A large woody vine with milky sap. Widely distributed in forests at low and medium altitudes on Mount Maquiling.

The fruit which is known as *bayati* in Los Baños and in the neighboring towns is used as fish poison.

The fish poison may be prepared from the fruit as follows: Ripe fruit is roasted until it turns coffee-colored, then pulverized and mixed with earthworms cut into pieces the size of kernel of corn. This mixture is ready for application as fish poison. In the Pansipit River, the practice is to mix the powdered *bayati* with crushed katang, small fresh water crabs.

The application of the poison is accomplished by scattering the mixture in a pool of water or in any portion of the river where the water is quiet. Application in the evening is recommended. The stunned fish may be collected early next morning.

8. *Derris polyantha* Perk. Leguminosae. Common names: tugli, tubli (Tagalog).

A woody vine found in the provinces of Rizal, Laguna, Batangas, and Tayabas. It is found under cultivation in the towns of Tanauan and Santo Tomas, Batangas, and Tadalac, Los Baños, Laguna.

The roots of this vine are pounded and then scattered in a pool of water. The procedure is repeated as many times as is deemed necessary in order to extract as much as possible the juice present in the roots. It has been found by experience that a bundle of roots 50 centimeters long and 10 to 15 centimeters in diameter when thoroughly pounded will be sufficient to treat a pool, one meter deep and about 10 meters wide. Said to be more effective in salt water than in fresh water. The poison is found to take effect almost immediately after application.

MATERIALS FOR DYEING

The most common procedure followed in the preparation of plant materials for dyeing cloth, fish nets and lines is as follows: The bark or other portion of the plant is cut into pieces, put in a petroleum can or other container in which it can be boiled in water for at least two hours; the duration of boiling depends upon the shade of color desired. The decoction is cooled and the nets and cloth are soaked in it for a few hours and then dried. If a deeper color is desired, the nets or cloth may be soaked for the second time in the decoction.

The foregoing method may be followed in the preparation of dyes from the following plants numbered from 1 to 21 inclusive.

1. *Pithecolobium dulce* (Roxb.) Benth. Leguminosae. Common names: kamachile; kamachilis; kamanchile.

A tree of medium size found throughout the Philippines at low and medium altitudes. Common along sandy beaches of Laguna de Bay, and in the coastal regions of Batangas Province.

The bark is utilized for tanning and dyeing purposes; produces brownish gray color.

2. *Leucaena glauca* (Linn.) Benth. Leguminosae. Common names: ipilipil; Santa Elena; Jerusalem.

A small-sized tree found in abundance along hillsides at low altitudes in Laguna and Batangas provinces.

The bark is used to dye fish nets. The color produced is brownish-red.

3. *Sesbania grandiflora* (Linn.) Pers. Leguminosae. Common names: katurai (Tagalog, Ibanag, Pampango).

A small-sized tree found in the settled areas at low and medium altitudes, often planted in yards and along fences in Batangas and Laguna provinces.

The bark is used to dye fish lines and nets; color is brown.

4. *Parkia javanica* (Lam.) Merr. Leguminosae. Common name: kupang (Tagalog, Tagbanua, Ilokano).

A large-sized tree found in nearly all parts of the Philippines in forests at low and medium altitudes. Common and abundant on the lower portion of Mount Maquiling, Laguna, and also on Mount Lobo, Batangas.

The bark is used for dyeing cloth and nets; color produced, brownish-red.

5. *Acacia farnesiana* (Linn.) Willd. Leguminosae. Common name: aroma (Sp., Tagalog).

A small-sized tree found throughout the Philippines in open grass lands and thickets at low and medium altitudes. Common along waste settled areas in Batangas and Laguna provinces.

The bark and the fruit are used for dyeing nets and fish lines. The fruit, preferably when nearing maturity, is generally used. The color of the dye is dark-blue to black.

6. *Terminalia edulis* Blanco. Combretaceae. Common name: kalumpit (Tagalog).

A medium- to large-sized tree, found in all or most islands and provinces of the Philippines. Common along creeks on Mount Maquiling, Laguna, and also on Mount Lobo, Batangas.

The bark is used for dyeing, produces dark-blue color.

7. *Terminalia catappa* Linn. Combretaceae. Common name: talisai (Tagalog, Bagobo, Bicol, Visayan, Pampango).

A medium- to large-sized tree found throughout the Philippines along seashores; often cultivated inland.

The bark is used for dyeing; color is brownish to bluish.

8. *Terminalia pellucida* Presl. Combretaceae. Common name: dalinsi (Tagalog).

Medium- to large-sized tree, common in forests on Mount Maquiling at low and medium altitudes.

The bark is used for dyeing; produces dark-blue color.

9. *Terminalia nilens* Presl. Combretaceae. Common name: sakat (Pampango, Tagalog).

Medium-sized tree found in primary forests at low and medium altitudes on Mount Maquiling.

The bark is used for dyeing.

10. *Buchanania arborescens* Blume. Anacardiaceae. Common name: balinhasai (Ilocano, Tagalog).

Small- to medium-sized tree found throughout the Philippines at low and medium altitudes. Quite common in second growth forests on Mount Maquiling, Laguna and also on Mount Lobo, Batangas.

The bark of this tree is used for dyeing; produces reddish-gray color.

11. *Ceiba pentandra* (Linn.) Gaertn. Bombacaceae. Common names: boboi (Bicol, Tagalog); kapok (Visayan).

Medium-sized tree planted in settled areas throughout the Philippines.

The bark of this tree is used for dyeing. The color produced is pale red to brownish.

12. *Eugenia cumini* (Linn.) Druce. Myrtaceae. Common name: duhat (Tagalog, Visayan); lombai (Ilocano, Pampango, Tagalog, Central Visayan).

Medium- to large-sized tree but usually stocky; found throughout the Philippines. Planted in some regions, in many regions it grows spontaneously. Common and abundant in the open places and grass lands on Mount Maquiling, Laguna and on Mount Lobo, Batangas.

The bark is used for dyeing, producing reddish-pink color.

13. *Sandoricum koeljape* (Burm. f.). Merr. Meliaceae. Common name: santol (in most dialects).

Medium-sized tree found throughout the settled areas of the Philippines, planted and semi-cultivated. Abundant in second growth forests on Mount Maquiling.

The bark of this tree is used for dyeing. Color produced is reddish-brown. It is usually used for dyeing fish nets.

14. *Macaranga tanarius* (Linn.). Muell.-Arg. Euphorbiaceae. Common names: binoña (Tagalog, Pampango, Visayan); binuña (Tagalog).

Small-sized tree of wide distribution in the Philippines; characteristic of thickets and second growth forests at low and medium altitudes on Mount Maquiling, Laguna.

The bark is used for dyeing. Color produced is reddish-brown.

15. *Jatropha curcas* Linn. Euphorbiaceae. Common names: physic nut; tubang bakud (Tagalog); tuba (Bicol, Tagalog).

A shrub of wide distribution in the Philippines; usually very common in hedges in and about towns of Batangas and Laguna provinces.

The bark is used to produce dark blue dye.

16. *Glochidion philippicum* (Cav.) C. B. Rob. Euphorbiaceae. Common names: bagna (Tagalog); ibalbaan (Tagalog).

Small-sized tree found throughout the Philippines; common in open places and grass lands at the foot of Mount Maquiling.

The bark is used to dye cloth and fish lines. The color produced is reddish-brown.

17. *Achras zapota* Linn. Sapotaceae. Common name: chico (Tagalog and most dialects).

Small-sized tree, cultivated in most parts of the Archipelago.

The bark is used for dyeing; color produced is reddish to dark brown.

18. *Artocarpus blancoi* (Elm.) Merr. Moraceae. Common name: antipolo (Tagalog).

Large-sized tree of wide distribution in the Philippines; is common in thickets and forests at low and medium altitudes. Rather common in primary forests on Mount Maquiling and on Mount Lobo, Batangas.

The bark is used to produce reddish-grey dye.

19. *Artocarpus cumingiana* Tréc. Moraceae. Common name: anubing (Tagalog, Bicol, Visayan).

Small- to medium-sized tree found throughout the Philippines. Common in open places and grass lands on Mount Maquiling and Mount Lobo, Batangas.

The bark is used for dyeing.

20. *Trema orientalis* (Linn.) Blume. Ulmaceae. Common name: anabiong (Tagalog, Visayan).

Small- to medium-sized tree found throughout the Philippines. Common in second growth forests on Mount Maquiling and also on Mount Lobo, Batangas.

The bark is used for making reddish brown dye. This dye is generally used to color cloth and fish lines.

21. *Peltophorum inerme* (Roxb.) Llanos. Leguminosae. Common name: baringbing (Tagbanua).

A medium-sized tree rather common along the sandy beaches in Batangas Province. Extensively cultivated in Manila and in other towns as a shade tree. Planted along the road in Camp Eldridge, Los Baños, Laguna. The bark is used for dyeing. The resulting color is reddish-brown.

For plants numbered 22 to 35, inclusive, the method of preparing dye is as follows: Either follow method of preparation as prescribed for plants numbered 1 to 21 inclusive or cut the bark into pieces and soak in water for from fourteen to twenty days. Cloth, fish nets, fish lines and *sinamay* (abaca cloth) may then be dyed in the decoction thus obtained.

22. *Xylocarpus granatum* Koenig. Meliaceae. Common name: tabigi (Tagalog, Bicol, Tagbanuan, Visayan).

Small-sized tree found in mangrove swamps bordering tidal streams throughout the Archipelago.

The bark is used for dyeing, producing red to dark brown color.

23. *Xylocarpus moluccensis* (Lam.) M. Roem. Meliaceae. Common name: piagau (Tagalog, Visayan).

Small-sized tree found along the open beaches in the towns of Bolbok and Lobo, Batangas.

24. *Ceriops roxburghiana* Arn. Rhizophoraceae. Common name: tañgal (Tagalog, Bicol).

Small-sized tree found in all the mangrove swamps in the Philippines.

The dye prepared from the bark of *C. roxburghiana* is very effective in dyeing cloth, nets, and fish lines.

25. *Ceriops tagal* (Perr.) C. B. Rob. Rhizophoraceae. Common name: tañgal (Tagalog, Visayan, Pampango).

Small-sized tree, very common and abundant in all mangrove swamps in the Philippines.

26. *Rhizophora candelaria* DC. Rhizophoraceae. Common name: bakauan-lalaki (Tagalog).

Small-sized tree with prominent prop-roots, found throughout the mangrove swamps in the Archipelago.

The dye produced from the bark of this tree is reddish brown.

27. *Rhizophora mucronata* Lam. Rhizophoraceae. Common name: bakauan-babae (Tagalog).

Small-sized tree with prominent prop-roots, found throughout the mangrove swamps in the Philippines.

28. *Bruguiera conjugata* (Linn.) Merr. Rhizophoraceae. Common name: busain (Bicol, Tagalog).

Small-sized tree found throughout the mangrove swamps in the Philippines.

29. *Bruguiera cylindrica* (Linn.) Blume. Rhizophoraceae. Common name: pototan-lalaki (Tagalog).

30. *Bruguiera parviflora* (Roxb.) W. & A. Rhizophoraceae. Common name: langarai (Visayan, Tagalog).

Small- to medium-sized tree which grows straight and tall. Found throughout the mangrove swamps in the Philippines.

31. *Bruguiera sexangula* (Lour.) Poir. Rhizophoraceae. Common name: pototan (Visayan, Tagalog).

Description, local distribution, same as other species of *Bruguiera* given above.

32. *Heritiera littoralis* Dryand. Sterculiaceae. Common names: duñgon-late (Tagalog, Visayan), duñgon-dagat (Bicol).

A medium- to large-sized tree found along the seashore throughout the Philippines. Abundant along the beaches and the edges of mangrove swamps of Batangas Province.

The dye prepared from the bark of this tree is reddish-brown. Cloth, *sinamay*, fish lines, and nets are dyed with success with this dye.

33. *Pterospermum niveum* Vidal. Sterculiaceae.

A small- to medium-sized tree of wide distribution in the secondary forests at low altitudes of the Philippines. Found also in primary forest of Mount Maquiling.

34. *Pterospermum obliquum* Blanco. Sterculiaceae. Common name: kulakatiñgan (Tagalog; kulatiñgan (Bicol).

A small- to medium-sized tree of wide distribution in the Philippines at low and medium altitudes. Quite common in primary forests at the foot of Mount Maquiling and Mount Lobo, Batangas.

35. *Pterospermum diversifolium* Blume. Sterculiaceae. Common name: bayok (Tagalog, Bicol); bayog (Tagalog, Bicol, Pampango, Visayan).

A small- to medium-sized tree of wide distribution in the Philippines. Common in dry forests on Mount Maquiling, Laguna, and on Mount Lobo, Batangas.

36. *Entada phaseoloides* (Linn.) Merr. Leguminosae. Common names: gogo (Tagalog, Bicol, Tagbanua); gugu (Tagalog).

A large woody vine, found throughout the Philippines in forests at low and medium altitudes. Cultivated in most towns of Batangas Province and also in Los Baños, Laguna.

The stem is pounded and crushed in water. The cloth or nets are soaked in the mixture for about twelve hours. The color produced is khaki.

37. *Cocos nucifera* Linn. Palmae. Common names: niog (Tagalog); coconut.

Very extensively cultivated in the Philippines.

The husk of young green nuts is cut into pieces and boiled in water, and the decoction produced is used for dyeing. It gives bluish black color. It is used to dye cotton thread, cloth and *sinamay*. *Salap* for catching shrimps, prawns and dulong, *Mirogobius lacustris* Herre (in Laguna de Bay) are generally made from *sinamay* cloth dyed with this dye.

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GOAT RAISING¹

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Of the Department of Animal Husbandry

WITH SEVEN TEXT FIGURES

Given judicious treatment, a goat of good breeding should prove a boon to the owner instead of a nuisance and a liability as is ordinarily the case. It is a mistake to consider the breeding and care of goats with indifference and to allow them to roam at will to the detriment of truck gardens and landscape vegetation. This circular is intended to so present the different phases of goat management that by following the instructions one would be able to feed and care for a herd of goats intelligently and profitably.

GOATS AS DAIRY ANIMALS

Raising goats for milk purposes is more profitable than to raise them for meat. When milk is the object, dairy animals should be the aim in breeding. As a number of the males and undesirable does, however, will have to be disposed of as meat stock, production of good meat animals is a secondary aim.

What breed to use

The common native goat is admittedly a poor producer of milk, although occasionally an exceptionally large-sized doe possesses a well-developed mammary system. Large amounts of milk are obtained only from dairy pure breeds or those possessing some blood of a standard dairy breed. Foreign breeds of dairy goats have been imported many different times into the Philippines, but with the exception of the Indian goats, special care has been required to perpetuate any of these as pure breeds. Consequently, appreciable quantities of milk can be expected only from the Indian breed or from does that possess varying proportions of foreign blood. These grades can not be expected to equal the performance of the imported parent but they are superior to the native dams in milk production, and exhibit hardiness and adaptability to local environment quite equal to them.

The work of the College of Agriculture, University of the Philippines, in establishing a Philippine breed of dairy goat that will approach the dairy qualities of the Anglo-Nubian breed and the adaptability and easy-keeping advantage of the Indian goat is showing encouraging results.

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How to choose the productive doe

The animal unit on which depends the success or failure of a dairy goat is the doe. For this reason, it is important that she be selected with care and intelligence. First of all, the size must be satisfactory; the larger the doe the greater is her milk production likely to be. Also, a large doe is able to withstand adverse conditions better than a small one; that she gives a heavier carcass when she is no longer useful for dairy purposes is another advantage. A good constitution as shown by the depth of chest and capacious barrel should be considered in selecting a doe. Constitutional vigor is essential for the proper functioning of active milk-manufacturing tissues of a productive udder. The udder should be large, wide and pendulous with teats that are well-formed and of good size. A productive udder feels soft and yielding to the touch, a hard and fatty udder characterizes low-yielding milk gland. Just after milking, a good udder appears wrinkled and much reduced in size. An udder that is large and symmetrical but possesses much connective tissue, thus retaining its shape even after milking, although pleasing to the eye is not capable of producing a large amount of milk. The doe's legs should be straight and strong. Sound legs are useful in traveling over pastures when the animal is grazing. The front teeth should also be examined. To be able to graze or browse efficiently all sets of incisors should be present and sound. A good doe should also show fondness and care for her young; this characteristic is indicated by a motherly docile expression of her face and eyes. A doe with coarse features of the head may be indifferent to her young, and in some cases actually mean towards them.

Whenever possible it is always desirable to secure the actual performance of a doe as to the amount of milk she produces. If records are available, the total production during the period of lactation should be obtained. Some does may give moderate quantities of milk daily and yet produce milk for a long period of lactation; others may have a short milking period but yield abundantly at each milking time. In the absence of any well-kept records of production the daily milk yield of a doe will give a fair idea of her milking ability. Probably, under Philippine conditions, a liter of milk daily may be considered as above the average performance.

Select buck of good breeding and conformation

As much care, if not more, should be taken in the selection of a buck to head the herd as in choosing the does. The buck represents one-half of the blood composition of the stock so that the degree of improvement or deterioration of the herd depends a great deal upon him. The first consideration is the breeding of the buck. If given especially good feeding and care, a pure bred buck of one of the improved milch breeds, as the Anglo-Nubian goat, may be kept for breeding purposes. Animals born in the

region in which they are to be used are likely to be better acclimatized and live longer than those imported. The Indian bucks and grades of the delicate breeds have, however, the advantage of possessing practically the same hardiness as the natives do, hence, are able to survive under ordinary conditions. While the progeny of the grades do not have uniformity in the different characteristics and performance of their parents, a goodly proportion of them are much better in production than the native.

The buck should be the heaviest animal in the herd so as to cause improvement in size. As with the doe, both the chest and barrel should



Fig. 1.—An Anglo-Nubian grade doe possessing good size and conformation. Her production in last milking period was 166 liters of milk in 241 days.

be well-developed in the buck. Not only should the chest be deep but it should be wide between the legs. The back should be fairly straight to give strength and beauty. The rump is naturally short and drooping in goats but those exhibiting comparatively longer and more elevated hind quarters should be looked upon with favor. The legs should be strong enough to withstand the active life of an aggressive buck. To enable him to breed many does successfully the testes should be large and well let down. Above all, a buck should be able to transmit his good qualities to his progeny. His ability to do this is indicated by the rugged and coarse

development of the front region comprising the head, neck and shoulders. There should be style in his appearance when his head and neck are raised high, and the hair on top of his neck and back should be standing when he is rutting. He should be active and always in readiness to breed a doe that comes in heat. An energetic buck is beneficial in being able to arouse the sexual desire of an otherwise passive doe thus increasing the percentage of females that are successfully bred each season.



Fig. 2.—Note the masculine features of this buck. Anglo-Nubian and Indian blood predominate in his make-up.

MANAGEMENT

Feeding and care of general herd

The general herd consists of dry and pregnant does, weanlings and castrates. If the young females are to be bred early, bucks may be placed in the herd for mating purposes.

On large holdings provided with ample space for grazing, the general herd should be pastured most of the time so as to lower the cost of maintenance. Good results can be obtained by changing the pasture as frequently as evidences of over-grazing and pollution are manifest. Even with an abundance of feed still available in a pasture, to keep a herd graz-

ing on it for an undue length of time is certain to make it a breeding place for parasites harmful to them.

Breeding goats as well as growing and fattening stock can be raised solely on pasture feeds. Goats enjoy feeding on a large variety of plant growth so that brush lands together with the common pasture grasses afford an ideal combination for their well-being. It also appears that goats possess a keen power of selecting the very feeds suitable for them; hence, there is little danger of their eating poisonous weeds. If grass is the only available feed in the pasture, goats will subsist on it with good results. As a rule, however, the greater the variety of vegetation in the pasture the better its feeding value. The presence of leguminous plants because of their high protein content will help much in improving the quality of the pasture. As goats suffer greatly when wet they should not be pastured when there is a period of rainy weather. Instead, the herd should be placed in a pen well protected from draft and provided with a clean, solid floor, and given cut green feed or hay. If the atmosphere is humid and cold, and especially if there is hard wind, a small amount of cheap grain feed like rice bran will help in maintaining normal vigor in a herd of goats. The care of a herd includes, of course, watering and salting. It is a good idea to provide a watering trough in the pen where they may drink at any time they please. Salt may be placed in a box in the same pen in sufficient quantity and so placed that the animals can have access to it at any time.

Buck needs rich feed and good care

Because of the drain on his body incident to his work as a breeding animal, a buck requires special attention to his feeding. Besides green feed that he gets in the barn or in the pasture, he should be given grains of the proper kind; and the manner of feeding should be so adjusted as to make him take the proper amounts. The buck, like any breeding male, is fickle about his feed, especially during the breeding season. It is best to confine him in a separate pen far away from the pen where the does are fed. Generally, shelled corn is the most palatable feed for him. But to make his ration richer in protein, copra meal may be given in fair amounts. If leguminous seeds, like mungo, are plentiful and not expensive, they may be substituted for copra meal. Rice bran, being generally cheaper than corn, may be used as long as the buck relishes it. In selecting the roughage for his feed it is advisable to gather such palatable leguminous vines as are found in the locality. Peanut hay may be prepared as it is readily eaten by goats. Whenever possible the buck should have the freedom of the pasture where he can select the plants he likes besides getting the benefit of the open air. A common mistake in the care of the buck is over-feeding him. The result is that it will take some time before he can be made to again eat enough of the feed that he generally likes. For best

results feeds may be placed before a buck in quantities he will readily clean up although this necessitates frequent feeding in order that he will get a sufficient amount each day.

Services of buck should be regulated

The common practice of utilizing the services of a breeding buck is to turn him loose with the does at all times. It is apparent that with this method a buck may cover a breeding doe many times more than is necessary thus reducing his breeding efficiency and causing a rapid lowering of his vitality and usefulness. To obviate the excessive waste of breeding material and energy of the buck the number of does in a herd may be limited to from 20 to 25 for each male.

The highest breeding efficiency of a buck can be secured only when he is confined and his services are regulated. To accomplish this he is put with the does at a stated period during the day. This should be done for an hour or so daily, so long as there are does in the herd that are open. Does that are in heat are generally passive and do not exhibit marked signs of oestrus. The buck is, however, capable of determining the breeding female which he readily covers as soon as observed. One breeding is ordinarily sufficient for successful fertilization. Afterwards the buck is returned to his pen until the next day. Does that have been bred the previous day seldom receive the buck again. With this system it is obvious that a buck can cover a large number of does without materially undermining his health.

Milking does require good feeding and proper handling

Given a number of desirable productive milking does, the most important matter to consider is their feeding. Only proper amounts and the right kind of feeding stuff can be expected to produce a good flow of milk from the does. The goat, with its limited capacity for feed, should not be expected to ingest enough nutrients from roughages to produce milk to its capacity. Hence, in feeding productive does a generous amount of grain should be given.

On the basis of palatability, a mixture of grains composed of 5 parts, by weight, of shelled corn, 3 parts of copra meal and 2 parts of rice bran is recommended for milking does. Other seeds or mill by-products that are available and free from toxic substances may be used, especially those of a leguminous nature. As much of this mixture should be placed before the does as they will consume in about one hour of feeding. About 200 grams of grain can be consumed at one time by one animal weighing around 28 kilograms. Grain feed is generally given in the evening. Exceptionally high milk yielders may be given a little grain also in the morning.

In the daytime, milch does should be allowed to go with the general herd in the pasture. This is a good practice as the animals under favorable

conditions find outside environment most beneficial to their health. The variety of feed available to the animals in the pasture is conducive to greater milk production. At night the does are given roughages. Roughage should be furnished them in the daytime, also, if they are kept in the barn because of inclement weather. Napier grass has been observed to be most palatable to goats and being a productive plant it may be cultivated for the purpose. Butterfly pea (*Centrosema plumieri* (Turp.) Benth.) is also well relished by them. This is a leguminous vine which readily spreads and grows wild in a field from seeds which have dropped from mother plants growing there. The relative richness in nitrogen of legumes should make this plant particularly desirable for feeding milch does.

The milk production and period of lactation of does vary. Six Anglo-Nubian grade does at the College of Agriculture milked on an average of 294 days during one lactation, the average production being 136 liters. One of them gave a total yield of 167 liters of milk in 435 days. One Indian grade doe in the same herd yielded 390 liters of milk during a lactation period of 202 days.² With the exception of long time milkers, does should be bred as soon as possible. Records at the College of Agriculture show that they may breed as early as from 6 to 92 days, or an average of 46 days, from the time of parturition. The average period of gestation among them, also from data at the same College, is 149 days.

Care of kids

The most delicate stage in the life of a goat is during the first six months when they are with their dams. The younger the kid the greater the risk is in raising it. It may be emphatically asserted that good results can be obtained in raising kids only if they are allowed part of the milk of the dam. This is essential, especially in the first days when they are unable to feed on grass or concentrates.

Soon after parturition, the dam must be observed from a distance to be sure that she licks off the mucous covering the body of the kid, particularly around the nostrils. If she fails to do this, the attendant should immediately wipe off the viscid material covering the muzzle and body, later rubbing the skin to dry it and to stimulate blood circulation. The kid's navel should be painted with tincture of iodine as soon as possible. Some kids die in a herd from tetanus, the causal organism probably making its entrance through the raw navel cords. For the first half hour or so a kid is too weak to stand up, but when it stands it will be seen to walk around slowly seeking for the teats of its mother. If, after several hours the udder of the dam appears fully distended indicating that the new born kid has not succeeded in getting its first supply of milk, the doe may

²Villegas, Valente, and Alfredo D. Pablo. 1926. A preliminary study of the dairy qualities of goats. The Philippine Agriculturist 15: 415-422. Fig. 1-2.

be tied and the kid's mouth directed towards the teats to suck. Sometimes early feeding can be induced by opening the mouth of the kid and milking into it. The first taste of milk arouses a greater desire for more and the teat being softer the kid is better able to suck. As much as possible of the first milk, or colostrum, should be taken by the kid to cause the removal of its fecal matter, or meconium. After the kid has obtained its supply of milk if any is left in the udder it should be milked by hand to prevent udder trouble.

For the first three days, the kid and dam should be left together unmolested, enabling the kid to suck milk at its pleasure. The fourth day the dam may be separated from her young during the night so that she will be ready to be milked the following morning. From this time for a month the kid and dam should be put together in the barn during the daytime; after this time the dam should be allowed to go with the main herd to the pasture in the afternoon. The kid gets its milk supply in the morning while with its mother in the barn. The time of separation between the doe and her kid should start at one o'clock in the afternoon and last till the next morning when the dam is milked. This arrangement should be followed until the kid is entirely separated from the mother at weaning time when it is six months of age.

Kids begin to nibble on feed as early as three weeks of age. The younger they are fed with concentrates and roughages the better they will be suited to take care of themselves after weaning. Early feeding of a kid also lessens the drain on its mother thus letting her maintain, if not increase, the amount of milk produced for human consumption. Kids should be fed ground concentrates when young. A mixture of grains consisting of one part, by weight, of copra meal, three parts of corn meal and five parts of rice bran is recommended. In place of copra meal, mungo may be given. Fairly young and fresh soilage of the most palatable kind may be placed in the feed racks at all times. Water and salt should also be provided *ad libitum*.

While young the kids should be made to lie on dry, clean bedding at night so they will not get chilled. Sound rice straw answers for this purpose very well. Over-crowding should be avoided. Narrow, small corners in the barn are objectionable. The construction of walls and partitions of barn should be such as to prevent drafts. Solid walls keep the kids warm at night. As often as possible the floor space should be swept and it should be kept dry. During feeding, the kids should not be allowed to get into the feed racks; if they do so the feed will not only become dirty, but may become contaminated with parasites from the manure which may be dropped over it. The kids are fond of romping in the open, especially during good weather. For this reason, when they are not feeding they should be driven out from the barn as often as possible to get such exer-

cise. Well-fenced paddocks which have been rested for a long time may be used for this purpose. Like the adults, the kids should be taken to shelter as soon as indications of coming rain are in evidence.

At times, certain mothers in a herd may be observed to be indifferent to their young. In fact, some does refuse to nurse their kids. The best that can be done in this case is to hold the dam while her kids are sucking. The practice should be repeated regularly three or four times daily, and soon it will be found that the mother will allow the kids to feed.

A sanitary and convenient method of milking

Cleanliness is essential to the production of a safe, wholesome milk from a doe. Not only should the milking be done sanitarily but provision should be made so it can be done conveniently. For convenient clean

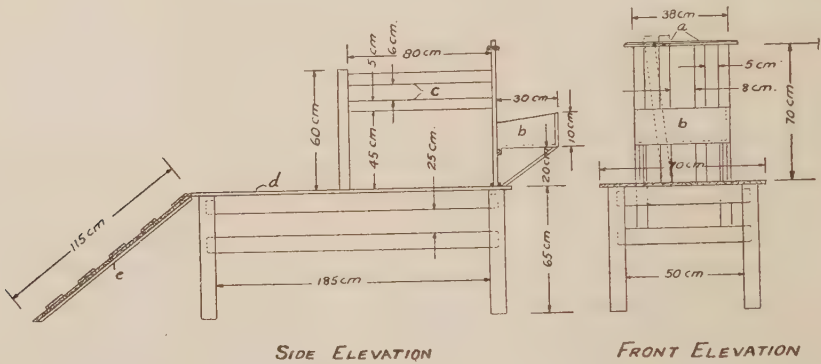


Fig. 3.—A practical platform for milking goats. *a.* stanchions, *b.* grain box, *c.* side of stall, *d.* floor, *e.* ladder.

milking the platform shown in figure 3 is recommended. With the animal raised to a satisfactory height, the milker can sit on a stool and work comfortably and in a cleanly way. Moreover, the advantage in position enables him to milk the animal dry. The sides of the stall and the adjustable stanchion in front make the does behave well during milking. The grain in the box in front attracts the animal to the platform, and the doe can feed during the milking.

When the doe is in position on the platform, the udder and adjoining parts should be brushed well, and the udder wiped with a clean rag, freshly dipped in hot water. To milk, the upper region of teats are pressed by the fingers on both sides, either together or separately, the milk dropping into a container which is covered by a cheese cloth as strainer. The teats should be stripped to the last drop. By massaging the udder more milk may be obtained. The milking of the doe should not stop until only about 25 cc. of milk is produced at each milking time, then she may be dried. At the

time she is to be dried, milking may be continued as long as the udder shows distension, but to hasten drying the animal is not milked dry.

To prevent the presence of undesirable goat odor in the milk it is important that the milch does be kept in a separate pen without the buck twelve hours before milking.

Disposal of wether goats and low-yielding or old does

As soon as wether goats have reached the proper age for slaughtering purposes they should be disposed of to reduce the cost of maintenance of

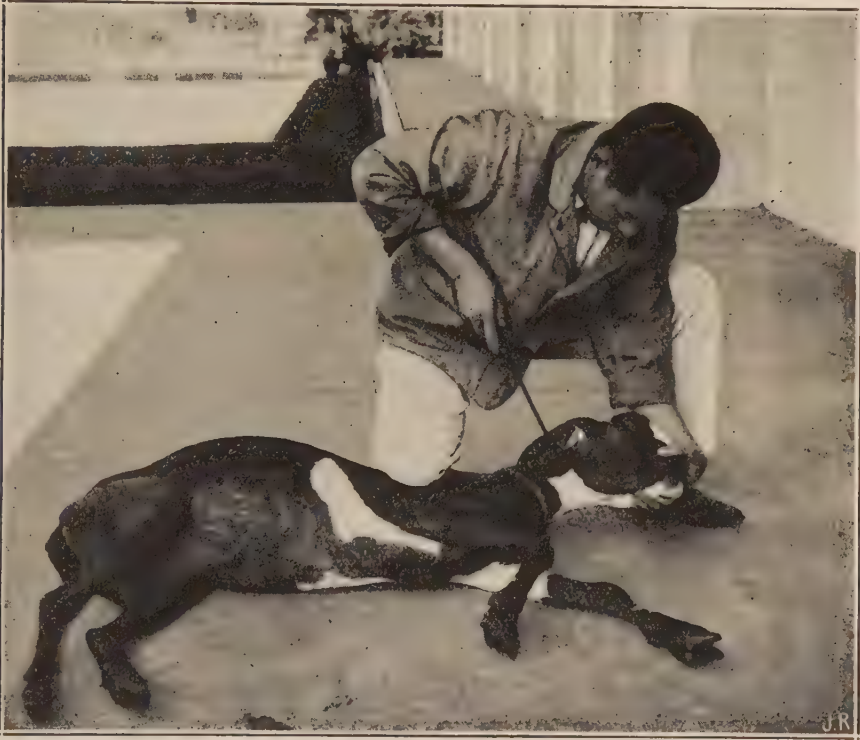


Fig. 4.—A proper method of killing a goat. Observe the position of the knife and the point through which it is thrust.

the herd. Over-crowding with its consequent evils, is also remedied by their removal. Low-yielding does that would serve only as boarders should be sold for meat as soon as their production has been determined. Considering the probability of multiplying the number of poor yielders which low producers may cause, it is evident that their presence in the herd becomes more detrimental the longer they are kept and allowed to procreate. If they are to be fattened for a better market, spaying them may be practiced. Old does give a very tough and poor kind of meat. A better car-

cass will be obtained if they are not allowed to become too old before slaughtering them. It is, therefore, only in the case of exceptionally high producers when all possible offspring from them is desired that does should be kept to an age that make them undesirable for meat.

Goat's meat, known as chevron, is considered by some a delicacy. Specific local preparations of this meat for the table are highly prized by those who have acquired a taste for them. Common methods of cooking may also be followed with good results but, in any case, in selecting goats for meat uncastrated males that have already developed the masculine characters should not be considered. The flavor of the meat from such animals is very disagreeable and is largely responsible for the prejudice against goat's meat.

The best age of a goat for slaughtering is between eight months and two years. The meat of young goats possesses less of the goat flavor. It is tender and juicy. Beyond two years of age the meat is tough. As a goat makes very little growth after this age there is no advantage in keeping it. Unsexed goats fatten well and give the best quality of meat.

How to butcher and dress goats

For 12 to 18 hours previous to slaughtering, the goat should not be fed or watered. The body should be brushed so as to make skinning sanitary. To put the goat down in preparation for sticking, the butcher places himself on the right side of the animal. The left fore shank is then caught by his right hand and pulled towards him under the chest and behind the right foreleg of the animal, causing it to fall on the left side of its body. The muzzle is now held by the left hand. The point of the knife is stuck at the corner back of the lower jaw with the blade directed towards the ventral side of the animal so that at one stroke the blood vessels and tissues are cut causing instant death. The flow of blood is collected in a can placed below the cut end. More blood may be drained if the hind quarters are raised up. Next, the hind legs are spread by placing a piece of wood with one end in each leg through a hole made between the tendon and bone above the hock. A rope by which the animal is hung is then tied at the middle of the spreader. The skin is opened, first, from the inside of each of the hind legs towards the ventral side of the body. A cut is also made at this time around the rectum and the latter is tied around to prevent the feces from dropping and soiling the carcass. The cut from around the rectum is drawn downward at the center of the abdomen until the neck is reached. The skin of the front legs is cut on the inside and connected with the main cut at the abdomen. Skinning is started from the cut openings and continued towards the back. The thin paper-like tissue, known as fell, underneath the skin should be left with the carcass but care should be exercised so that cutting the skin is avoided as much as possible. At certain places the knuckle of the hand may be used in

separating the skin from the carcass. A slight twist and push of the knuckle is sufficient. After skinning, the viscera are removed. The median line is opened, the first cut being made between the hind quarters. Before proceeding to cut downward the chest should be opened, after which the two openings are joined together. By so doing the whole viscera may be made to drop out after the diaphragm has been cut around. To prevent the urine from pouring into the carcass, the neck of the bladder is tied before the internal organs are pulled out. The carcass is now wiped with a clean moist rag. The backbone is sawed down dividing it into halves and the carcass is now ready for disposal to retailers.

The dressing percentage of goats slaughtered at the College of Agriculture is, on the average, 43.35. The range is from 36.1 to 50.0 per cent. It is evident that the younger and better the condition of the animal the higher the dressing percentage will be.

Early castration of bucks advisable

The earlier castration is done the less the danger of ill effects from the operation. The meat also improves in quality when unsexing is done at the proper time. The best time to castrate is when the kid is about one week old. Another advantage in castrating the kid young is that the operation is simpler than with an older animal. An opening is made by cutting off the tip of the scrotum through which the testes and the membrane covering them are pressed out and bitten off from their attachment to the body. The testes may also be removed with forceps. Tincture of iodine is then applied on the wound and within two days it will be healed³. The castration of mature and old bucks has to be done with the use of emasculator or artery forceps because of the vascular and well-developed spermatic cords goats at this age possess. The tip of the scrotum is capped off or an incision may be made across the bottom. The testes still covered by a tough membrane, called the *tunica vaginalis*, are pressed out through the opening of the scrotum and a cut is made on the *tunica vaginalis* to expose the testes. Each testis is then pulled out gradually, the membrane surrounding the spermatic cord, or mesorchium, being severed from its connection with the *tunica vaginalis* and the remaining portion is pushed towards the body. The crushing blades of the emasculator are now applied on the spermatic cord as close to the body as possible. The instrument is clamped for about one minute to obtain a complete crushing effect. Before and after the operation all parts which have been exposed to infection should be disinfected with a three-per cent creoline solution, or a like disinfectant. A mixture of pine tar and cosmoline in such proportions as to make it brownish-black in color is then smeared over the wounded parts and adjoin-

³Gaviola, Vicente D. 1929. Observations on the time of healing by the slit and cap methods of castration. The Philippine Agriculturist 18: 191-200.

ing surfaces, mainly to drive off flies. The animal should be confined in a pen for about 12 hours after castration to hasten the coagulation of blood. For about two weeks, or during the time of healing, the scrotum should be observed regularly, the fly repellent being applied again whenever necessary until the wound is healed.

Trimming of hoofs

If the hoofs of goats are neglected they grow very long causing the gait to become unsteady. Untrimmed hoofs accumulate dirt that may emit bad odors rendering the premises unpleasant. For these reasons, as part of the routine to follow in the management of goats, their hoofs should be trimmed whenever necessary. The cutting is made level with the body of the foot. To avoid injury of the sensitive part, thin portions are pared off at a time as the cut approaches the softer tissues. Small sharp pincers are convenient to use in cutting the horny edges. Later,

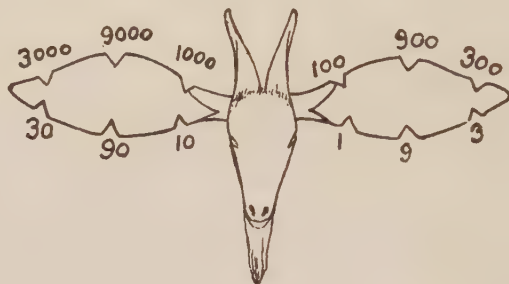


Fig. 5.—Showing position of notches on goat's ears with equivalent numbers.

in trimming the foot to a good form a jackknife is used. If a deep cut is made causing the foot to bleed, tincture of iodine should be applied on the wound, and the animal kept in a pen until healing has taken place.

Herd recording

Whether for inventory or other purposes, the identity of each animal in a herd of goats is necessary. Numbering the animals, from one upward, in the herd records, consecutively as they are born, is advisable. The ears of each animal may be so notched that it can be identified with its record number. Figure 5 shows the location of these notches on both ears. With each animal having its own identification number, it is possible to record important events of its life. As a rule, it would be well to record the date of birth, sex, parentage, nature and date of disposal and returns of each goat. With does, additional information such as the date of kidding, the number of young at each kidding and milk production should be recorded. These data will be found useful.

Housing facilities and feeding racks

Good housing facilities enhance the sanitary condition of the premises thus minimizing the danger from disease, while the proper construction of feeding racks is an important factor in increasing the efficiency of feeding goats. To maintain cleanliness in a goat barn, a concrete flooring is most desirable. Parasites have no chance of multiplying on a concrete floor, provided that it is cleaned regularly. The partitions between pens should

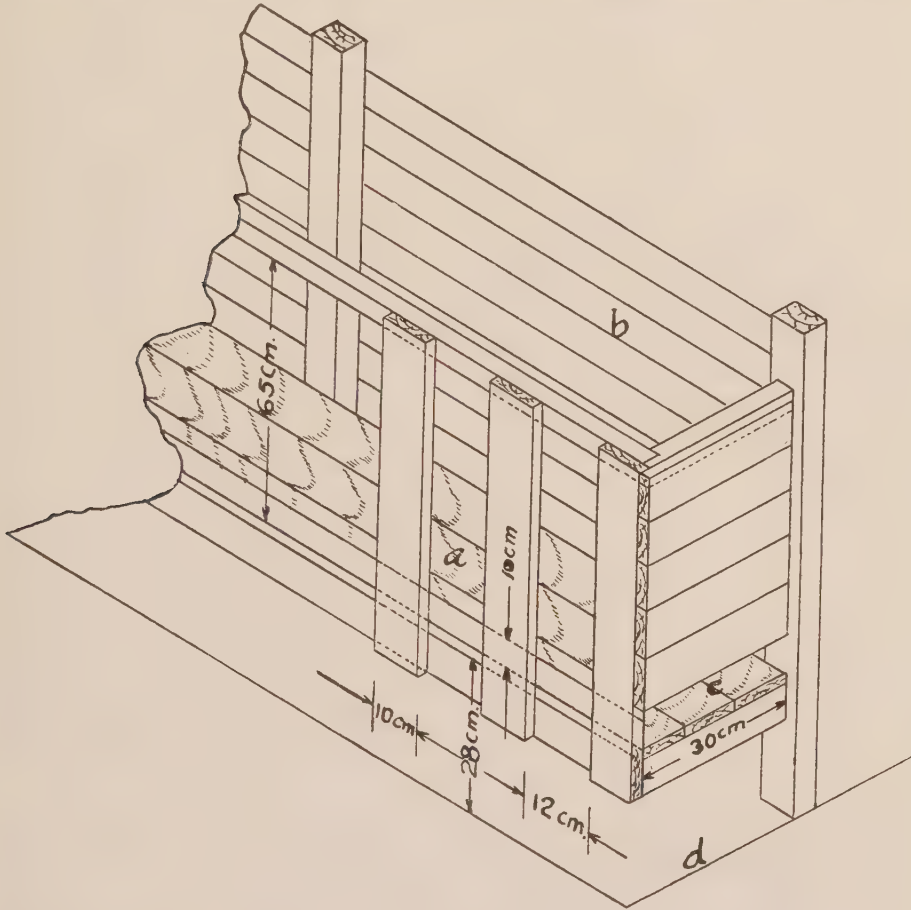


Fig. 6.—Feeding rack for mature goats; a. head space; b. wall; c. floor of rack; d. ground floor.

be 135 cm. high, except for bucks; here the height should be 170 cm. A solid wall around the pens 140 cm. high from the floor will protect the animals from drafts and keep the place warm at night. Ventilation is provided by apertures 8 cm. high from the floor below the wall.

The feed racks shown in figures 6 and 7 are satisfactory for feeding goats. The space inside is large enough to allow the heads of the animals

to move with freedom while feeding. A distance of 12 cm. between railings permits mature goats to put their heads through but prevents them from getting inside. With kids an opening of 10 cm. between railings is sufficient. Besides, a crosspiece nailed on the railings 25 cm. over the floor of the rack will be necessary to keep the kids from jumping into the feed rack.

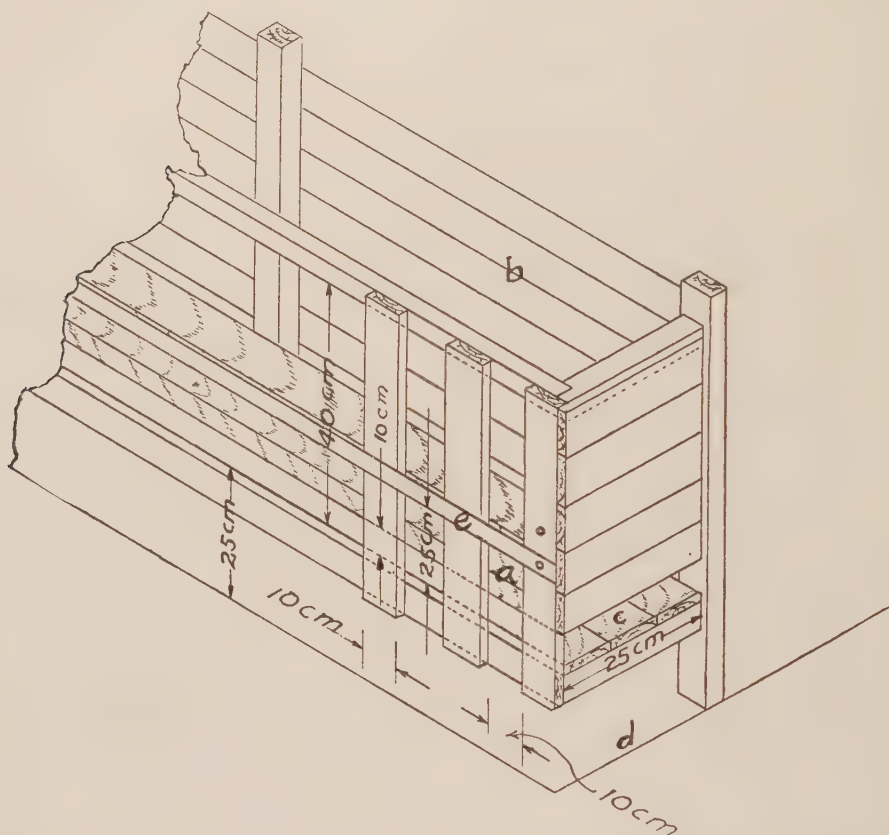


Fig. 7.—Feeding rack for kids; a. head space; b. wall; c. floor of rack; d. ground floor; e. crosspiece.

GOATS SUBJECT TO FEW DISEASES

The first year of a goat's life is the period when the most losses occur through death from various causes. Immediately after weaning, the kids are susceptible to disease because their vitality lowers a little until they have adapted themselves to the new feed.

Stomach worms (Haemonchus contortus Rudolphi)

The most common disease to which goats, particularly the kids, fall victim is parasitism caused by stomach worms. This parasite is thread-

like in appearance, measuring from three-fourths to one inch in length. It is a blood-sucking organism causing affected animals to become thin, pale and weak when large numbers of the parasite are present. Animals affected with this parasite may also exhibit a depraved appetite and scouring. If an animal which has succumbed to the disease is examined immediately, numerous stomach worms will be seen in the abomasum moving together as red and white threads.

Inasmuch as the goats become infected by feeding on contaminated pastures, it is evident that the incidence of the disease may be minimized by controlling grazing so that only pastures which have been sufficiently rested are used. Part of the life of stomach worms is passed in the body of the animal so that the removal of a herd of goats from a pasture for a time means the death of parasites dropped therein.

Copper sulfate is recommended in treating goats for stomach worms. A stock solution may be prepared by dissolving 56.7 grams of freshly powdered crystals of copper sulfate in 3.8 liters of water. Dissolve the powder in a little boiling water and then add cold water to make up the desired volume. The solution is given as a drench. The head of the animal is kept in a level position while the solution is being poured into its mouth. If the animal coughs while being drenched the head is released to prevent the liquid from getting into its lungs. The doses for the different ages are as follows: For kids three months old, 20 cc; for six months, 40 cc; for yearlings, 60 cc; for two-year-olds or older, 90 cc.⁴ Before the solution is administered the animal is fasted for about 18 hours, and again for six hours after the treatment.

Goats that are not badly infested may stand the attack of stomach worms fairly well if fed concentrates regularly.⁵ During the wet season when the vitality of the animals becomes lower permitting the parasites to multiply rapidly, losses from stomach worm infestation may be minimized by supplementing the grass feed with grain every evening when the goats are brought in from the pasture.

Tapeworm (Moniezia expansa Rudolphi)

Tapeworms offer a serious problem to the goat raiser because of the high mortality occurring among infested kids. The infestation of the animals in a herd, however, does not take place as rapidly as is the case with stomach worms. Only young kids die from this disease. Symptoms observed in animals attacked by tapeworms are similar to those having stomach worms. The affected animal becomes thin and weak, with pale mucous membrane. During cold weather the hair stands up and the animal looks dejected with its legs gathered close together, the abdomen tucked up and the back bent. A mixture composed of equal parts of one

⁴Bell, D. S. 1924. Treatment for stomach worms of sheep. Ohio Agric. Exper. Sta. The Monthly Bull. 9: 173-174.

⁵Boncato, Perfecto C. 1932. A study of the different methods for controlling stomach and intestinal worms in sheep and goats. The Philippine Agriculturist 20: 669-677.

per cent copper sulfate solution and one per cent by weight of powdered tobacco infusion, at the rate of 50 cc. for kids, is recommended. To prepare the tobacco infusion the material is soaked in water over-night. Previous to the administration of the medicine the animal should be fasted for 12 hours. If the infestation is heavy, the treatment may be made at intervals of three or four weeks in which case fasting the animals is not necessary.⁶ Of course, sick animals should be isolated from the healthy ones to prevent the spread of the parasite.

Foot rot

During the wet season in barns having dirt floors foot rot may become widespread and troublesome in a large herd. Affected animals become so lame that they are unable to go with the herd to the pasture to graze. The suffering an animal undergoes resulting from the pain and lameness causes it to lose flesh and become run down. When the diseased limb is examined, a sore emitting a foul odor will be found at the cleft between the halves of the foot. As soon as the animal is known to be thus affected, it should be confined in a barn which has a dry concrete or wooden floor. The wound should be thoroughly cleaned and washed with a disinfectant. After drying it with cotton, powdered crystals of copper sulfate may be dusted over it. At the beginning it should be dressed once or twice daily. Later on when the tissues appear dry and to be healing it may be treated at longer intervals. While animals are recovering from the disease they should not go over a wet pasture lest the rot may recur. Needless to say, animals under treatment should receive grain supplement to improve their condition.

Bloat

Goats may contract bloat; however, victims of this ailment are not common. Early signs of this malady that can be recognized are the unusual bulging of the left side of the abdomen, the wobbly gait while walking and failure of the animal to chew its cud. In light cases of bloat, the animal may be made to stand with its forelegs on a higher level than the hind and a piece of rope placed in its mouth and tied at the top of the head; as the animal chews the rope gas is belched. The elevated position of the front legs prevents the distended rumen from pressing against the respiratory organs; besides it also facilitates belching. Cold water may be douched over the left side of the abdomen. Five cc. of turpentine in 100 cc. of linseed oil may be given to the goat as a drench to arrest further gas production and to act as a carminative and purgative. In severe cases of bloat, a small instrument known as trocar and cannula is thrust inward and forward at the highest point midway between the point of the hip and the last rib. The trocar is slowly pulled out allowing the gas to escape in small jets through the cannula. The cannula is then removed and the wound painted with tincture of iodine.

⁶Hall, Maurice C. 1923. Diagnosis and treatment of internal parasites. 102 p., 82 fig. Chicago: Veterinary Medicine.

THE PHYTIN CONTENT OF SOME PHILIPPINE FOOD MATERIALS¹

CANDIDO L. BAGAOISAN

"Phytin is an organic phosphoric acid compound occurring as a reserve material in seed, tubers, fruits, vegetables and root crops. It may be prepared as a white nearly tasteless powder and is used in medicine as a general stimulant." Its empirical formula was reported by Anderson (1914) to be $C_6H_{18}O_{24}P_6$.

Investigations have shown that the phosphorus in phytin, in contradistinction to that in inorganic compounds, is readily soluble in water and in dilute acids. Hart and his collaborators (1909) showed that phytin is a soluble compound which is a good source of phosphorus in a form that can be assimilated easily, hence its importance in metabolism. Patten and Hart (1904) found that it is both a diuretic and a laxative.

A perusal of the available literature reveals the fact that no quantitative estimate of the phytin in Philippine food materials has been reported. Hence, the importance of this study the object of which was to determine the phytin content ($C_6H_{18}O_{24}P_6$) of some Philippine food materials.

The investigation was started on April 1, 1930 and terminated October 15, 1930. The work was conducted in the laboratory of the Department of Agricultural Chemistry of the College of Agriculture, Los Baños, Laguna.

REVIEW OF LITERATURE

Posternak (1903) discovered that phytic acid or anhydrooxymethylene di-phosphoric acid is a constituent of green plants. Hart and Andrews (1903) found that practically all the phosphorus contained in vegetable foodstuffs is present as salts of phytic acid. Thompson (1914) found that in rice the polished grain contained the lowest percentage of phytin, and rice bran contained the highest. Anderson (1912) reported the presence of phytin in cottonseed meal, oats and corn, and reported the empirical formula of phytic acid to be $C_6H_{24}O_{27}P_6$. He found (1915) this acid to be the product of the hydrolysis of inosite hexaphosphate, otherwise known as phytin.



¹This paper presents in part the results given in a thesis presented for graduation, 1930, with the degree of Bachelor of Science in Agriculture from the College of Agriculture No. 414; Experiment Station contribution No. 813. Prepared in the Department of Agricultural Chemistry under the direction of Dr. F. O. Santos.

Rather (1918) stated that the phosphorus compound of the seeds of plants consists to a considerable extent of the salts of inosite phosphoric acid or acids known as phytin. Averill and King (1926) determined the phytin content of fifty-seven samples of foodstuffs using modifications of the Heubner and Stadler methods (1914). Their analyses were confined to cereals, legumes and nuts. Their analyses show that cereals, such as wheat, rye, hempseed, millet seed, and rape seed vary in their phytin content from 0.68 to 3.33 per cent; legumes, such as soybeans have a phytin content varying from 1.79 to 2.58 per cent; nuts, such as almond nuts, brazil nuts, filbert nuts, hickory nuts, pecan nuts, peanuts, and walnuts contain from 1.40 to 3.30 per cent, all calculated as $C_6H_{12}O_{24}P_4$ on air dried samples.

METHODS

Preparation of samples for analysis. Cereals and legumes: A complete sample representing the material on hand was ground in a porcelain mortar. The ground sample was passed through a 30-mesh sieve, and then mixed thoroughly and placed in a well-stoppered container. The sample thus prepared was ready for analysis.

The fruits were peeled and the edible portion sliced and mashed to a pulp in a mortar.

The tubers and root crops were washed thoroughly and dried in the laboratory. They were peeled carefully and the edible portion sliced and mashed in a mortar.

Tender, fresh vegetables were obtained for analysis. The edible portions were cut into small pieces and then crushed.

Moisture. The carefully weighed sample of the prepared material was placed in tared watch glasses and dried in the oven at 100° to 105° C. to constant weight. Duplicate determinations were conducted for each material. From the loss in weight, the percentage of moisture was calculated.

Phytin analysis. The principle of the quantitative estimate of the phytin content as proposed by Heubner and Stadler (1914) is based upon the fact that the iron salt of inosite phosphoric acid is very sparingly soluble in very dilute acids. Hence, the determination of the amount of inosite phosphoric acid in the presence of phosphoric acid or phosphoric acid esters the salts of which are soluble in dilute hydrochloric acid is carried by titrating with a solution of ferric chloride using ammonium thiocyanate as indicator.

The method used by Averill and King (1926) in their studies on the phytin content of foodstuffs was used in this investigation. This method

is a modification of that of Heubner and Stadler (1914). The details of the method are as follows:

A duplicate sample of the finely ground material was extracted with 200 cc. of 2% hydrochloric acid for three hours. The extract was filtered and three aliquot portions of 50 cc. were taken for titration. Each portion was diluted so that the concentration before titration was 0.6% hydrochloric acid. Ten cc. of 0.3% ammonium thiocynate solution were added as indicator and the phytic acid was titrated with a standard solution of ferric chloride.

It was observed during the preliminary work that the end point of the titration was difficult to judge because of the formation of a whitish precipitate. A highly colored pigment was present in some of the food materials studied, which gave a highly colored extract which made the titration to an end point almost impossible. The addition of a reagent which would remove this color without undergoing reaction with the extract was resorted to. Fuller's Earth was first tried, but because of its high iron and phosphorus content its use was discontinued. Blood charcoal was then tried and gave better results. The right amount to be used was found by repeated trials with both colored and uncolored solutions. It was found that at least 0.16 gram was required to remove the objectionable color.

The end point of the titration is reached when a drop of the titre produces a pale red color which persists for at least five minutes and does not disappear on shaking the container.

From the corrected volume of the titre used in a sample the phytin was calculated. The standard iron solution used contained 0.00196 gram per cc. One milligram of iron corresponds to 1.19 milligrams of phytin phosphorus (Heubner and Stadler, 1914) and the weight of phytin phosphorus was calculated to the weight of phytin by using the factor 3.55 (Averill and King, 1926).

RESULTS

The results are given in tables 1 and 2.

Table 1 shows the effect of the decolorizing agent (blood charcoal) in the determination of the phytin content of the sample under consideration. In some of the samples, as santol, tamarind, gabi, sugar beet, carrot, eggplant, banana flower, and tomato, the extract that was to be titrated was highly colored and at times turbid. The extracts of these samples were all treated with 0.16 gram of blood charcoal as a decolorizing agent. This amount of blood charcoal was found to give better results than 0.10 gram which did not remove the objectionable color. In all the trials less phytin was obtained by using 0.30 gram of blood charcoal than by using 0.16 gram. It is clearly shown in table 1 that there was a decrease in the phytin content actually determined as the amount of the decolorizing agent added was increased.

It may be seen in table 1, that with the addition of 0.100, 0.160, 0.300, and 0.500 gram of blood charcoal, there was a decrease in percentage of phytin for corn by 0.63, 0.57, 0.25 and 0.12, respectively. For rice bran addition of 0.100, 0.160, 0.300 and 0.500 gram of blood charcoal decreased the phytin obtained by 0.46, 0.38, 0.26 and 0.13 per cent, respectively. For rice (var. Inintiw, unpolished) the addition of 0.100, 0.160, 0.300 and 0.500 gram of blood charcoal decreased the phytin obtained by 0.64, 0.38, 0.25 and 0.08 per cent, respectively.

Table 2 gives the phytin content calculated as $C_6H_{18}O_{11}P_6$, based on oven dried samples. The percentage of phytin obtained for santol, eggplant, tamarind, gabi, sugar beet, carrot, banana flower and tomato is approximate because of the addition of blood charcoal which always gives lower results.

SUMMARY

Seventy-two Philippine food materials were analyzed for their phytin content. Of these, twenty-six were fruits; ten, cereals; five, legumes; three, tubers; eleven, root crops; and seventeen, vegetables.

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TABLE 1

Showing the effect of blood charcoal on the determination of the phytin content of the following uncolored samples

SAMPLE	AMOUNT OF BLOOD CHARCOAL	PHYTIN
	<i>gram</i>	<i>per cent</i>
Corn (Calauan Yellow Flint).....	without addition	1.11
	0.1000	0.63
	0.1600	0.57
	0.3000	0.25
	0.5000	0.12
Rice (the bran).....	without addition	1.06
	0.1000	0.46
	0.1600	0.38
	0.3000	0.26
	0.5000	0.13
Rice (var. Inintiw, unpolished).....	without addition	0.88
	0.1000	0.64
	0.1600	0.38
	0.3000	0.25
	0.5000	0.08

TABLE 2
Phytin content calculated as $C_6H_{18}O_{24}P_6$
Oven dried sample

FOOD MATERIALS	PHYTIN
	per cent
<i>Fruits</i>	
Ates, <i>Anona squamosa</i> Linn.	2.85
Avocado, <i>Persea americana</i> Mill (Unnamed seedling variety, skin, green, when ripe).....	2.45
Avocado, <i>Persea americana</i> Mill var. Lyon (ripe).....	1.25
Banana, <i>Musa sapientum</i> var. Lacatan (Blanco) Teodoro (ripe).....	5.11
Banana bungulan, <i>Musa sapientum</i> var. Sueveolens (Blanco) Teodoro (ripe)....	0.41
Banana saba, <i>Musa sapientum</i> var. grandis Teodoro (ripe).....	0.67
Chico, <i>Achras zapota</i> Linn. (ripe).....	1.45
Coconut, (Laguna type), <i>Cocos nucifera</i> Linn. (immature).....	4.58
Guava, <i>Psidium guajava</i> Linn. (ripe).....	2.72
Guayabano, <i>Anona muricata</i> Linn. (ripe).....	4.53
Lansones, <i>Lansium domesticum</i> Correa (ripe).....	1.10
Mabolo, <i>Diospyros discolor</i> Willd. (ripe).....	3.26
Mango, <i>Mangifera indica</i> Linn. var. Indian small fruited seedling (green).....	1.62
Mango, <i>Mangifera indica</i> Linn. var. Indian small fruited seedling (ripe).....	1.92
Mango, <i>Mangifera indica</i> Linn. var. Indian large fruited seedling (green).....	2.71
Mango, <i>Mangifera indica</i> Linn. var. Pico (green).....	1.07
Mango, <i>Mangifera indica</i> Linn. var. Pico (ripe).....	1.79
Mango, <i>Mangifera indica</i> Linn. var. Carabao (ripe).....	2.55
Mangosteen, <i>Garcinia mangostana</i> Linn. (ripe).....	0.68
Melon, <i>Cucumis melo</i> Linn. Small variety (ripe).....	1.55
Papaya, <i>Carica papaya</i> Linn. (long, ripe).....	1.27
Pili nut, <i>Canarium ovatum</i> Engl. (mature).....	0.92
Pineapple, <i>Ananas comosus</i> (Linn.) Merr. Native variety (ripe).....	3.37
Rimas, <i>Artocarpus cummunis</i> Forst.	0.75
Santol, <i>Sandoricum koetjape</i> (Burm. f.) Merr. (ripe).....	0.43 ^a
Tamarind, <i>Tamarindus indica</i> Linn. (immature).....	0.60 ^a
<i>Cereals</i>	
Corn, (malagkit), <i>Zea mays</i> Linn. (dried).....	1.52
Corn, <i>Zea mays</i> var. Calauan Yellow Flint (dried).....	1.11
Rice, (malagkit), <i>Oryza sativa</i> Linn. Unknown variety (dried).....	0.57
Rice, (the bran), <i>Oryza sativa</i> Linn.	1.06
Rice, <i>Oryza sativa</i> Linn. var. Inintiw (dried, unpolished).....	0.88
Rice, <i>Oryza sativa</i> Linn. var. Hambas (dried, polished, third class).....	0.41
Rice, <i>Oryza sativa</i> Linn. var. Inadhika (dried, polished, second class).....	0.41
Rice, <i>Oryza sativa</i> Linn. Unknown variety (dried, polished, third class).....	0.37
Rice, <i>Oryza sativa</i> Linn. var. Ramai (dried, polished, first class).....	0.25
Rice, <i>Oryza sativa</i> Linn. Unknown variety (dried, polished, second class).....	0.24
<i>Legumes</i>	
Mungo, <i>Phaseolus aureus</i> Roxb. var. Dull Yellow (dried).....	0.92
Peanut, <i>Arachis hypogaea</i> Linn. var. Lemery (dried).....	3.75
Peanut, <i>Arachis hypogaea</i> Linn. var. Spanish White (dried).....	2.09
Peanut, <i>Arachis hypogaea</i> Linn. var. Kinorales (dried).....	3.23
Soybean, <i>Glycine max</i> (Linn.) Merr. (dried).....	1.34

TABLE 2—(Continued)

FOOD MATERIALS	PHYTIN
	per cent
<i>Tubers</i>	
Gabi, <i>Colocasia esculentum</i> (Linn.) Schott.	1.24 ^a
Potato Irish, <i>Solanum tuberosum</i> Linn.	1.70
Ubi, (irwi), <i>Dioscorea alata</i> Linn.	1.56
<i>Root crops</i>	
Carrot, <i>Daucus carota</i> Linn.	5.27 ^a
Cassava (angular), <i>Manihot utilissima</i> Pohl.	0.93
Cassava (rough intermediate), <i>Manihot utilissima</i> Pohl.	1.99
Cassava, <i>Manihot utilissima</i> Pohl var. Aipin Valenca.	1.79
Cassava (kapo white), <i>Manihot utilissima</i> Pohl.	1.23
Cassava (white smooth, intermediate), <i>Manihot utilissima</i> Pohl.	1.24
Cassava (Leyte unknown No. 5), <i>Manihot utilissima</i> Pohl.	1.18
Cassava, <i>Manihot utilissima</i> Pohl var. Mendioca Sao Pedro Preto.	1.14
Sincamas, <i>Pachyrrhizus erosus</i> (Linn.) Urb.	2.48
Sugar beet, <i>Beta vulgaris</i> Linn.	10.55 ^a
Sweet potato, <i>Ipomoea batatas</i> Linn. var. Samar Big Yellow.	1.05
<i>Vegetables</i>	
Ampalaya, <i>Momordica charantia</i> Linn. (fresh, tender)	7.65
Banana saba, <i>Musa sapientum</i> var. grandis Teodoro (flower)	0.79 ^a
Cabbage, <i>Brassica oleracea</i> Linn. (fresh, tender)	4.11
Cucumber, <i>Cucumis sativus</i> Linn. (fresh, yellow native variety)	3.05
Eggplant, <i>Solanum melongena</i> Linn. (fresh, tender, long, purple, native variety) .	2.04 ^a
Gourd, <i>Lagenaria leucantha</i> (Duch.) Rusby (fresh, tender, long)	7.65
Lima bean, <i>Phaseolus lunatus</i> Linn. (immature)	0.87
Malungay, <i>Moringa oleifera</i> Lam. (fresh, tender, fruits)	2.31
Onion (Bombay), <i>Allium cepa</i> Linn.	4.70
Patola, <i>Luffa acutangula</i> (Linn.) Roxb. (fresh, tender with edges)	7.84
Patola, <i>Luffa cylindrica</i> (Linn.) M. Roem. (fresh, tender, smooth)	4.66
Pepper, <i>Capsicum annum</i> Linn. var. Bolivian (fresh, tender fruits)	1.98
Radish, <i>Raphanus sativus</i> Linn. (fresh, long, white)	2.53
Sitao, <i>Vigna sinensis</i> var. <i>sesquiipedulis</i> Fruw. (fresh, green, white fruits)	8.58
Squash, <i>Cucurbita maxima</i> Duchesne (fresh, tender, fruit)	1.89
Sweet pea (chicharo), <i>Pisum sativum</i> Linn. (fresh, tender fruits)	5.31
Tomato, <i>Lycopersicum esculentum</i> Mill. (ripe, native kind)	6.68 ^a

^aApproximate amount.

NOTE: THE FIRST DEAN RETURNS

To few builders is given the opportunity to visit in after years the work of their hands. Dr. Edwin B. Copeland, founder and first dean (1909-1917) of this College is one of these few so favored. He has returned (on leave from the University of California) to the Islands as Agricultural Adviser in the Bureau of Plant Industry.

When he arrived on March 10 he was met at the pier by a delegation from the faculty of the College consisting of Dean Gonzalez, Doctor Mendiola, Doctor Espino, and Doctor Uichanco,. All these men were students of the First Dean in the earliest days of the College.

The following day, accompanied by President Palma, Doctor Copeland came to the College—seeing it again for the first time since August, 1917. With Dean Gonzalez as “courier” the First Dean toured the Campus. Memory served him well. Little had he forgotten. His praise of the changes and the development was hearty. Dean Gonzalez was host at a luncheon at Molawin Hall for the honored and well-loved Founder, at which eighteen old-timers were guests.

In the evening of April 6 in Molawin Hall, those of “Copeland’s time” still on the Campus with a half a dozen or more of the same ilk from Manila, reinforced by a number of a later era gave a “welcoming” dinner to the Founder. To see seated at the long tables a hundred or more men, some whose experience on the Campus covered the whole span of time from the year of the founding of the College, 1909, to 1932, others with periods varying in length within that span, could but stir the pools of memory and start the flow of currents of reminiscence.

True, Time had touched gently not only the First Dean but also these, his “boys”. Increase in girth, some facial lines, a bit of ponderosity in movement, a touch of gruffness in voice, an assurance in manner in the “boys.” In the First Dean, only a few more flakes of snow on hair and beard, a mellower note in voice that was never harsh; a more evident ripple of sympathy in the smile that was ever understanding. Otherwise, it might have been the same Doctor Copeland who sat at his farewell dinner on the Campus in August, 1917.

The tables were gay with flowers. At the speaker’s table were two semblances of miniature trees, one loaded with kalamondin (*Citrus mitis* Blanco), the other with Indian mango (*Mangifera indica* Linn). The menu “cards” were half an internode of bamboo, artistically decorated. The menu in agricultural phraseology was beautifully lettered.

In the remarks of Doctor Espino, the toastmaster, of Dean San Agustin of the College of Veterinary Science and Dean Gonzalez and finally the guest of honor there was much in the "reminiscing" that was laugh-provoking. In the talks of the First Dean and the present dean, with the incidents of Auld Lang Syne were interwoven "words of truth and soberness."

A song by Miss Manahan and a violin solo by Doctor Aquino with Professor Roa at the piano added to the pleasure of the evening.

All that were present look forward to the association in the coming months with Doctor Copeland. Others in the College who are of later "growth" look forward to knowing the man whom they have known as a tradition—a sort of Zeus whose nod was final, an oracle whose verdict was never questioned.

From the Dean to the latest registrant, the whole College, including employees, from the Chief Clerk—whom the Founder broke in in Alfredo's "salad days"—to the humblest *ilik* swinger, cry "Welcome Doctor Copeland". Just to show they are up-to-date some shout "Mabuhay!"

NOTE: THE RURAL LIFE INSTITUTE

The First Rural Life Institute was conducted by the College of Agriculture at Los Baños for one week from March 28 to April 2, 1932. This institute was held at the request of the Philippine National Christian Council with the object of giving their rural workers an opportunity to receive instruction in agriculture and other allied subjects that they may give more practical service in the communities where they minister. Thirty-six religious leaders, 28 men and 8 women, were enrolled. Eighteen provinces were represented. The delegates showed extraordinary interest in all the subjects presented by the faculty of the College of Agriculture during the six days session. All the facilities of the College were made available, thus making the Institute not only instructive and interesting but also profitable and beneficial in widening the horizon of those who attended. The following talks and demonstrations were presented by the faculty members of the College of Agriculture:

March 28: (a) Lecture on and a demonstration of the different methods in plant propagation.

March 29: (a) A talk on poultry raising for profit. (b) A demonstration of sack weaving out of bast fibers obtained from locally grown plants.

March 30: (a) A lesson on hog raising. (b) An exhibition with lecture concerning the good types of farm animals. (c) A discussion on the rôle of coöperative credit associations in helping Philippine

farmers. (d) A demonstration of the extraction of starch from cassava with the use of machinery. (e) An illustrative lecture on methods for preparing coffee beans for market.

March 31: (a) A study of the fish problem in rural communities and its solution, followed by an excursion to the College Limnological Station at Mayondon. (b) A lecture on tenancy and rural improvement (possible remedies for checking increase of tenancy). (c) Some useful hints on vegetable growing.

April 1: (a) Illustrated lecture on some common insect pests and plant diseases, and their control. (b) A lecture on fertilization and manuring; illustrated lecture on the different classes of soils and their identification in the field.

April 2: (a) A talk on food and nutrition for a rural community. (b) Methods of sewage disposal and water supply in a rural community. (c) A discussion of some problems of the rural population and their solution.

It is to be regretted that the time of the Institute was so short, otherwise a more detailed presentation of the subject matter could have been given by the faculty members who conducted the lectures and demonstrations.

It is sincerely hoped by the College that those who attended will find that they received help commensurate with the time, effort and money expended. If so, this educational extension feature should become an annual institution in the College.

ABSTRACT¹

Inbreeding experiment with Hambas rice variety. PEDRO B. JUACHON. (*Thesis presented for graduation, 1930 from the College of Agriculture No. 416; Experiment Station contribution No. 815*).—The main object of the experiment was to record observations on the effects of self-pollination in the Hambas variety of rice.

Two plantings were made in this experiment. In the first planting, seedlings that were vigorous and tall were used. The inbred grains of the F₁ were planted for the second planting.

The individual characters studied were: (1) Number of bearing and non-bearing culms; (2) relative proportion of completely filled, almost filled, half-filled, partly filled and empty panicles; (3) number of filled and empty caryopsis per head; (4) yield of the inbred strains; and (5) presence of red and white cuticled grains.

¹Abstract prepared as part of the required work in English 3a, College of Agriculture.

The author obtained the following results:—

In the first planting there was obtained an average of 43 bearing culms and 10 non-bearing culms, 1178 filled grains and 5,040 empty grains per plant. In the second planting the average number of bearing culms was 40 and non-bearing culms, 11, with a production of 1,439 filled and 4,002 empty grains showing that the smaller number of bearing culms is accompanied by a higher percentage of filled grains. Open plants in F_2 produced an average of 29 bearing culms, 10 non-bearing culms, 2,706 filled grains and 1,206 empty grains. The number of desirable strains; namely, 91,692, 783 and 855 exceeded the undesirable ones; namely, 104, 174, 287, 405 and 475.

The author arrived at the following conclusions:

1. An increased production of bearing culms was not always accompanied by an increase in production of grains.
2. In the amount of grain production, F_2 plants were better than F_1 plants, but F_1 plants were better than F_2 plants for bearing culms.
3. In regard to yield, the control was better than the inbred plants, although the control had less number of bearing culms. This shows, therefore, that the treatment had some effect on the grain production.
4. The production of grain having white and red cuticle was due to the impurity as to grain color of the variety studied.

—Abstract by Juan Padilla.

CURRENT NOTES

The Fruit Grower in an interesting article on the value of tomato juice as a vitamin agent compares it with orange juice.

Orange juice having been given its full share of publicity with regard to its possession of a good all round average of vitamins, bids fair however to be outstepped by tomato juice, a food which is one of the richest sources of the three first discovered vitamins, A. B. C.

According to Henry C. Sherman, Professor of Chemistry at Columbia University who has classified these foods with respect to their vitamin contents—in Chemistry of Food and Nutrition.

Vitamin A—

Orange Juice 350. Tomato Juice (raw or canned) 2700.

Vitamin B—

Orange Juice about 150. Tomato Juice (raw or canned) 130-250.

Vitamin C—

Orange Juice 150-300. Tomato Juice (raw or canned) 150-300.

Dr. William Weston in the Journal of the American Medical Association (Vol. 95, p. 834) quotes Dr. Alfred Hess from his book on scurvy

as making the statement that infants can take twice as much tomato juice as orange juice without causing digestive disturbances.

Dr. Weston also gives the mineral content of both as follows:

	Oranges	Tomatoes
Iron.....	70.5	160
Manganese.....	7.6	26.7
Copper.....	4.75	15.3

Premiums totalling \$611,449 will be awarded at the Illinois State Fair this year.

—*Prairie Farmer.*

The latest immigrant to become commercially important in California is the papaya, a native of Brazil which has become widely distributed throughout the tropical and semitropical countries including the Central American countries, the Far East, Australia and South Africa. In the United States there are extensive plantings in Hawaii and Florida, a few plants in Texas and three in California.

—*California Cultivator.*

I find an Instructor is always "on the learn." I started a campaign among the children of the schools to plant each one a lime tree, talked to 15 or 16 sets of children, offered prizes, etc. Returning I found it had not taken on, so I switched off and asked 5 boys and 5 girls in each school to give me their names to put in my big book. Each child promises me to dig a hole 3 ft. square and 3 ft. deep and leave the hole open till I come, and in it I promise to plant for the child a good grapefruit.

Results have begun to come in and at Comfort Castle this month I spent a useful and happy half day carting round 8 children in my car to their homes where we all helped to fill in with good soil and manure, their excellently dug holes and planted the grapefruit. This apparently has taken on and I shall follow it up. The second thing I realized was that through the children I had got hold of a splendid lever to influence the parents, and the actual outcome proved it.

I have been encouraging members to buy even three or four good grafted or budded grapefruit of best quality. I am glad to report that I have just been able to send an order for 125 Marsh and Walters budded grapefruit. Which I shall be delivering to the different parties on December 4th. This is a good beginning for Agricultural instruction.

—*The Journal of the Jamaica Agricultural Society, February, 1931.*

Ripe Malayan coconuts average 0.5 lbs. of dry copra per nut.

The highest yield of oil and copra is obtained in Malayan approximately at the time of natural nut fall. . . .

The quality of Malayan copra would improve if overripe nuts were excluded.

—*The Malayan Agricultural Journal*, October 1931.

The Sultan Idris Training College, a large residential College founded and controlled by Government and modelled on the lines of an English public school, trains Malay pupil teachers for service as school masters in the Malay vernacular schools, and forms Malaya's sole source of supply in this respect. It is situated at Tanjong Malim, Perak, a rural area and is over fifty miles from the nearest large town. This is considered important as affecting the mental outlook of the students. The College course is of three years duration; there are 390 students. . . .

The aim of the Malaya vernacular schools as defined by the Government in 1920 "is not to turn out a few well-educated youths nor yet numbers of less well-educated boys; rather it is to improve the bulk of the people and to make the son of the fisherman or peasant a more intelligent fisherman or peasant than his father had been, and a man whose education will enable him to understand how his own lot in life fits in with the scheme of life around him". The great majority of the indigenous population of Malaya is engaged in agriculture, so that it has long been considered necessary for Malayan vernacular education to have an "agricultural bias".

—*Tropical Agriculture*, March, 1931.

COLLEGE AND ALUMNI NOTES

Dr. Richard Woltereck, Professor of Zoölogy in University of Leipzig and Director of Biological Station at Seeon, Bavaria, made the Campus his headquarters during March and part of April. With him as assistant was Dr. Willis Tressler, instructor in zoölogy in University of Buffalo, New York.

Dr. Woltereck was sent out by the University of Leipzig, the German "Not-gemeinschaft der Deutschen Wissenschaft", and the Prussian Academy in Science to investigate the differentiation of animals, their species and endemic (local) races in tropical lakes, to compare the conditions and effects of isolation in tropical lakes and islands with the same in European and North American post-glacial lakes which for the past twenty years he has made a subject of study. His work in the Philippines is supported by the Rockefeller Foundation. Doctor Tressler was sent by the same organization to the Philippines.

Before coming to the Philippines Doctor Woltereck spent six months in the United States and Canada investigating lakes and giving lectures in several of the principal universities. He was one month in Hawaii. From the Philippines, where he spent four months, Doctor Woltereck went to Netherlands Indies and British India.

While on the Campus, Doctor Woltereck was given every possible assistance by Doctor Villadolid of the Division of Zoölogy. Mr. Daniel Buñag, Senior student majoring in zoölogy, was detailed to assist Doctor Woltereck while he was on the Campus. He also accompanied him to the southern islands, Mindanao and Celebes.

Dean B. M. Gonzalez delivered the commencement address at the Silliman Institute in Dumaguete, Oriental Negros, on March 16. His theme was training for leadership.

On February 18, 19, and 20 Mr. E. D. Hester, U. S. Trade Commissioner, gave a series of lectures before the faculty and students on the trade relations between the United States and the Philippines. The lectures revealed careful and understanding study of the subject and to the audience were illuminating. Presenting his subject from the standpoint of the economist and student of world trade with the cold impersonality of the statistician, Mr. Hester's lectures were most convincing and his conclusions as shown by data impressive.

Mr. Hester is ably qualified to speak on this subject as he was on the faculty of this College from 1919 to 1925 as head of Department of Rural Economics. In fact, organized the department. Since his return to the Islands as Commissioner he has been economic and commercial adviser to the Governor General, consequently he has given careful analytical study to this important topic. The College warmly appreciates Mr. Hester's continual interest in the college of his teaching days.

Dr. Menchien Joshua Bau, Professor of Political Science in Peking University, was the convocation speaker at the College of Agriculture, on February 27, 1932. Dr. Bau, who was adviser to General Chiang Kai-shek, is a product of American institutions, being an alumnus of both John Hopkins and Columbia Universities. In his address, Doctor Bau's main theme was the Sino-Japanese conflict in Manchuria and Shanghai. As introduction he reviewed also the underlying causes and the outcome of the Russo-Japanese war of 1905. Doctor Bau spoke earnestly but remarkably free from bias, considering the present tenseness between his country and Japan.

Doctor and Mrs. Stanley W. Warren, of Ithaca, New York, were Campus visitors in February and March for four weeks. Doctor Warren is engaged by the University of Nanking as statistician, but he and Mrs. Warren left Nanking when the university was closed as a result of the Sino-Japanese trouble. Doctor Warren is the son of Dr. G. F. Warren, head of the Department of Agricultural Economics in Cornell University. Dr. and Mrs. Warren were classmates of Doctor Sacay of the Department of Education when he was in Cornell. It was to renew this friendship that they came to the Campus. Once here, they found it so delightful they stayed on until summoned back to China. The Cornellians on the Campus honored Dr. and Mrs. Warren with a dinner. Both while here and in letters received from them since they returned to China they expressed a warm liking for our Campus and its residents.

Dr. Felipe T. Adriano, Associate Professor of Agricultural Chemistry, tendered his resignation, effective January 23, 1932. Doctor Adriano has accepted the position of Chemist in the Bureau of Plant Industry.

Miss Katherine Turner, of the Department of English, spent the vacation in China, principally in Peking.

Miss Laura Mae Williamson was recently appointed instructor in English in the Rural High School. She will take the place of Miss Due Denny whose appointment expires in March, 1932.

Professor R. H. King of the Sugar Technology Division visited the centrals Santos-Lopez and Janiuay in Iloilo, La Carlota, Binalbagan, Bacolod-Murcia, Ma-ao, Talisay-Silay, Hawaiian-Philippine, Victorias, North Negros at Manapla, and Lopez in Negros Occidental, Bais in Negros Oriental, and Bogo-Medellin in Cebu from December 2 to 14, 1931. Professor King inspected the work of sugar technology students in their Sugar Mill Practice B course, and made arrangements for similar work for the coming senior class next year. He also sought to get acquainted with the problems and progress of the sugar industry in the Southern Islands.

On January 28, 1932, the Los Baños Biological Club held its sixty-ninth meeting in the Lecture Hall of the Department of Agricultural Chemistry. The following papers were read and discussed:

1. "Comparative studies on the value of various mash mixtures for laying hens."—By Dr. F. M. Fronda.

2. "Cost of harvesting cassava with the use of machinery."—By Assistant Professor A. Catambay.

On February 25, the same club in the same hall held its seventieth meeting. The following papers were read and discussed:

1. "The preparation and composition of Philippine vinegars."—By Dr. F. T. Adriano and Mr. J. Banzon. (Read by Mr. Banzon)
2. "The feeding and spawning habits of Ayuñgin (*Mesophistes plumbea* Kner), a common Theraponid of Laguna de Bay." By—Mr. Andres M. Mane.

On March 2, the same club in the same hall held its seventy-first meeting. The following papers were read and discussed:

1. "Modified ammonia bulb for total nitrogen determination by the Kjeldhal method."—By Mr. Leopoldo T. Villanueva.
2. "Gasanol, kerosene, alcohol, and gasoline as fuels for some makes of small gas engines."—By Mr. Santiago R. Cruz and Mr. Ignacio Ang. (Paper read by Mr. S. R. Cruz).

Just before close of College year *Farm Leaves* made its debut on the Campus. A most attractive—and what is more important—an interesting debutante it is. *Farm Leaves* is the product of the Aggie Pen Club. This is a 1931 organization, sponsored by the Department of English. The Club is limited to twenty members. The object is encouragement and development of ability in writing stories, sketches and verse. Miss Katherine Turner of the Department of English is the Adviser. The format of *Farm Leaves*—considering it is a mimeographed magazine—is excellent and the forty-four contributions justify it. Individual comment on contributions cannot be made, for in fairness each story, sketch or verse is worthy of commendation. The merit of the illustrations and the design on the green cover rather insist on the mention of the artist, Thuan Komkris.

The U. P. Rural High School held its first annual commencement exercises on March 21, with Dean Jorge Bocobo as the commencement speaker. The first graduating class was composed of the following: Hilario J. Santos (valedictorian), Prudencio O. Pacumbaba (salutatorian), Mariano S. Aban, Norberto Orbigo, and Victoriano G. Rivera.

Notice has been received from the Institut International d'Agriculture in Rome, Italy, that the *International Yearbook of Agricultural Statistics*, 1930-31, has been released for distribution. This book of 830 pages contains data on the area and population for 220 countries.

The second part is composed of a series of tables comprising for nearly 50 countries the available data concerning the uses for which the total area is employed, the apportion-

ment of cultivated areas between the different crops, agricultural production, numbers of the different kinds of livestock and the products derived from them. In the tables constituting the third part of the volume, have been indicated for nearly 40 agricultural products the area, production and yield per acre in each country during the last five years of the pre-war period and during each of the years from 1927 to 1930.

For each kind of livestock all available figures in the different countries have been grouped for the years 1913 and 1926 to 1930. A large part of the volume is devoted to statistics of the commercial movement of 42 vegetable products and 12 products of animal origin.

The following students were graduated from the College of Agriculture, University of the Philippines, on March 22, 1932:

Bachelor of Science in Agriculture

- | | |
|----------------------------------------|---------------------------------------|
| 1. Agudo, Eugenio A., B. Agr. '31. | 26. Mane, Andrés M., B. Agr. '29. |
| 2. Andaya, Eulogio V. | 27. Maranion, Estanislao T. |
| 3. Anioay, Domingo G. | 28. Mejia, Gaudencio G. |
| 4. Andrés, Pascual N. | 29. Meneses, Juan P. |
| 5. Aragon, Vicente B., B. Agr. '18. | 30. Muyargas, Agapito, B. Agr. '27. |
| 6. Atienza, Juan D., B. Agr. '29. | 31. Pablo, Alfredo D., B. Agr. '25. |
| 7. Badelles, Acelo G. | 32. Peliño, Anacleto R., B. Agr. '22. |
| 8. Bernardo, Fernando B. | 33. Perez, Antonio C. |
| 9. Bondoc, José B., B. Agr. '29. | 34. Quiaoit, Gregorio. |
| 10. Buhay, Gabino G. | 35. Reantaso, Sisenando, B. Agr. '28. |
| 11. Cabrera, David V. | 36. Reynes, Cosme O. |
| 12. Carambas, Petronilo A. | 37. Rillo, Artemio L. |
| 13. Dizon, Marcelo J. | 38. Saddul, José C. |
| 14. Erce, Pedro P. | 39. Santos, Dominador S. |
| 15. García, José C. | 40. Sevileno, Francisco M. |
| 16. Gesmundo, Artemio E., B. Agr. '30. | 41. Sumagui, Juan O., B. Agr. '31. |
| 17. Gonzalez, Nicolás L. | 42. Suratos, Felicísimo D. |
| 18. Gopez, Florencio Y. | 43. Tabije, Demetrio P. |
| 19. Isidoro, Francisco. | 44. Talatala, Lorenzo N. |
| 20. Javier, Vedasto. | 45. Tan, Dominador H. |
| 21. Joaquin, Lorenzo. | 46. Tenebro, Magno, B. Agr. '23. |
| 22. Lumang, Honorato E., B. Agr. '29. | 47. Tirol, Roberto H. |
| 23. Luna, José F. | 48. Villanueva, Fausto E. |
| 24. Magno, Ceferino L. | 49. Tucay, Juan. |
| 25. Magsino, Juan R., B. Agr. '22. | 50. Viradeja, Swasdi. |

Bachelor of Science in Sugar Technology

- | | |
|-----------------------|----------------------|
| 1. Abes, Gelacio P. | 4. Tek Hap, Pee |
| 2. Capati, Gerardo G. | 5. Rivera, Andrés L. |
| 3. Layug, Genaro S. | 6. Valera, Loreto V. |

7. Villas, Trinidad B., *Cum laude*

Bachelor of Agriculture

- | | |
|-------------------------------------|---------------------------|
| 1. Alonzo, Celestino S. | 7. Cero, Magdaleno M. |
| 2. Ang, Ignacio R. | 8. Cuevas, Numeriano |
| 3. Banaag, Leonardo | 9. Fajardo, Abelardo J. |
| 4. Barsana, José G. | 10. García, Pablo S. |
| 5. Caguicla, Elena M. (Miss) | 11. Gochangco, Diodati R. |
| 6. Caguicla, Purificación M. (Miss) | 12. Guzman, Jesus de |

- | | |
|--------------------------------------|---------------------------------|
| 13. Layos, Elias O. | 20. Palma, Adriel A. |
| 14. Manacop, Porfirio R. | 21. Rozul, Juan D. |
| 15. Malabayabas, Artemio P. | 22. Suleik, Akas |
| 16. Martinez, Julian R. | 23. Torres, Sergio M. |
| 17. Mercado, Ramón T. | 24. Tugade, Domingo P. |
| 18. Padilla, Juan S. | 25. Villanueva, Nicolás C. |
| (Awarded Baker Memorial Scholarship) | 26. Villegas, Leonisa J. (Miss) |
| 19. Pagcaliwagan, Santiago T. | |

For the Certificate in Agricultural Education

1. Serrano, José A., B. Agr. '27.
2. Tolentino, Andrés F., B.S.A. '24.
3. Varona, Albino P., B.S.A. '29.
4. Yango, Clemente E., B. Agr. '24; B.S.A. '25.

Master of Science

1. San Pedro, Ambrosio, B.S.A. '30.

The "Joaquin J. Gonzalez medal" was awarded to Mr. Trinidad B. Villas. This medal is awarded to the student obtaining the highest average in scholastic records for collegiate course.

Among the twenty-six receiving degree of Bachelor of Agriculture were three young women: Leonisa J. Villegas, Purificacion M. Caguicla, and Elena M. Caguicla. This brings the number of women in the College Alumni Association up to four. Just what special lines, if any, these women Bachelors of Agriculture will follow the College sibyl has not revealed.

Summary of Registration for Summer School, 1932.

Regular Students.....	322
Extension:—	
Poultry Raising only.....	59
Total.....	381

On the evening of March 5, in the College Auditorium the Varsity Letters, College Letters, trophies and medals for the year 1931-32 were awarded.

The program follows:

PART I

1. Opening Remarks.....Dr. R. B. Espino, President of
Los Baños Colleges Sub-board
of Athletic Management
2. Song—U. P. Band.....Audience.
3. Winners U. P. Los Baños Intramural Leagues.
 - (a) Basket ball.....C.A. (Sophomores)
 - Volley ball.....Rural High School
 - Football.....C. A. (Freshmen)
 - Tennis.....C.A. (Juniors)

(b) Winners General Intramural Championship Leagues.

C.A. (Seniors) and C.A. (Sophomores) tied for first place.

PART II

- | | |
|----------------------|---------------------------------------|
| 1. Song—"Wahoo"..... | Intramural Athletes |
| 2. Championship..... | U.P. Manila <i>vs.</i> U.P. Los Baños |
| | Colleges |
| Basket ball..... | U.P. Manila |
| Volley ball..... | U.P. Los Baños |
| Tennis..... | U.P. Manila—Unit II |
| Boxing..... | U.P. Los Baños |
| Baseball..... | U.P. Manila |
| Football..... | U.P. Los Baños—Unit IV |
| Track and Field..... | U.P. Los Baños—Unit IV |
| Carnival Relays..... | U.P. Los Baños—Unit IV |
| 3. Song..... | College and Varsity Letter men |

PART III

- | | |
|----------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Comments..... | Prof. C. C. Bartolomé |
| 2. Distribution of Prizes: | |
| Veterinary Science..... | { Dean G. San Agustin
Miss T. Aquino |
| Forestry..... | { Prof. C. Sulit
Miss V. Mondoñedo |
| U.P. Rural High..... | { Dr. F. M. Sacay
Miss L. Cleto |
| Agriculture..... | { Dean B. M. Gonzalez
Miss A. Balvin (Freshmen)
Miss P. Elayda (Sophomore)
Miss E. Odijar (Junior)
Miss P. Caguicla (Senior) |

Mr. Nicolas Machan, the director of physical education in the Los Baños Colleges, deserves much praise for the care and thought given to the planning of the program. And he desires to give here much credit to Miss Elvie Fraser of the Department of English for suggestions and aid at rehearsals and drilling of singing. The broadcasting plan of last year was used again—with Acelo Badelles again at the megaphone (well concealed)—short wave—Station DEFEAT.

The following cups were won by the Los Baños Associated Colleges. All are handsome silver trophies:

1. For basket ball—Cup given by Hon. Antonio de las Alas, Speaker *pro tem* House of Representatives.
2. For volley ball—Cup given by C. Alkan and Co.
3. Soccer football—Cup given by Roces and Co.
4. Tennis—Silver figure (foot high) given by Hon. Jorge B. Vargas, Under Secretary of Department of Agriculture and Natural Resources.

Pennants awarded for second places were given by General Trading Co. for basket ball; by C. Alkan and Co. for volley ball; by Brias Roxas, Inc. for soccer football; by Mizuno Sporting Goods Co. for tennis.

ATHLETIC ACTIVITIES FOR COLLEGE YEAR

(C.A.)=College of Agriculture; (C.V.S.)=College of Veterinary Science; (F.S.)=. Forest School; (R.H.S.)=Rural High School.

There were four championship events in the Intramural Leagues in the Associated Schools and Colleges of the University of the Philippines at Los Baños for the College year 1931-1932. They were basket ball, volley ball, football, and tennis.

There were seven units: I. C.A. (Freshmen), II. C.A. (Sophomores), III. C.A. (Junior), IV. C.A. (Senior), V. C.V.S. (College of Veterinary Science), VI. F.S. (Forest School), VII. R.H.S. (Rural High School).

I. *Basket ball:*

The first championship event for Intramural Athletic Leagues was basket ball for one round robin. The C.A. Seniors and the C.A. Sophomores ties for first place with no defeat. The championship was won by the Sophomores in the final game breaking the tie. The following were the winners in this event:

First place.....	C.A. (Sophomores)
Second place.....	C.A. (Seniors)
Third place.....	C.A. (Juniors)
Fourth place.....	R.H.S.

II. *Volley ball:*

The second Intramural Championship was volley ball for one round robin. Rural High School won the event with no defeat. The following were the winners of this event:

First place.....	R.H.S.
Second place.....	F.S.
Third place.....	C.A. (Sophomores)
Fourth place.....	C.A. (Seniors)

III. *Football:*

The third event of the Intramural League was soccer football for one round robin also. Three units, C.A. Freshmen, C.A. Juniors and C.A. Seniors tied for first place. Another round robin for these three Units was necessary to determine the first, second, and third places for this event. The following were the final winners:

First place.....	C.A. (Freshmen)
Second place.....	C.A. (Seniors)
Third place.....	C.A. (Juniors)
Fourth place.....	C.A. (Sophomores)

IV. *Tennis:*

The last Intramural Championship event was tennis. The event was conducted by elimination. Each Unit had two singles and doubles. C.A. Juniors won the championship in the final matches by eliminating all other units and defeating the C.A. Seniors in the final matches. The following were the winners in this event:

First place.....	C.A. (Juniors)
Second place.....	C.A. (Seniors)
Third place.....	C.A. (Sophomores)
Fourth place.....	F.S.

V. *The General Championship:*

Unit II C.A. (Sophomores) and Unit IV C.A. (Seniors) tied for the General Championship by piling up 40 points each to their credit.

The following were the results of the General Championship of the Intramural League:

NOTE:—First place, 20 points; second place, 12 points; third place, 8 points; and fourth place, 4 points.

	Basket ball	Volley ball	Football	Tennis	Total points
C.A. (Freshmen).....	0	0	20	0	20
C.A. (Sophomores).....	20	8	4	8	40
C.A. (Juniors).....	8	0	8	20	36
C.A. (Seniors).....	12	4	12	12	40
C.V.S.....	0	0	0	0	0
F.S.....	0	12	0	4	16
R.H.S.....	4	20	0	0	24

VI. *Inter-section Contests:*

There were eight events in the Inter-Section contests between U.P. Manila and U.P. Los Baños Colleges. Los Baños Colleges captured five out of the eight events.

The first event of the U.P. Inter-Section Contests was basket ball. This event was won by U.P. Manila.

The second event was boxing. U.P. Los Baños boxing team won this event by taking three bouts out of four.

The third event was football. U.P. Los Baños won by decisively defeating U.P. Manila eleven in two straight games.

The fourth event was volley ball. U.P. Los Baños won the event by defeating U.P. Manila team in two straight games.

The fifth event was tennis. Four Units participated in this event. Units I, II, III, were U.P., Manila and Unit IV, U.P., Los Baños. This event was won by U.P. Manila Unit II.

The sixth event was the track and field meet held at Manila on January 16 and 17, 1932. This was a notable meet, for one Philippine and five U.P. records were shattered during the two-day meet. Unit IV, Los Baños Colleges won this event with a total of 65 points. The following were the results of the meet:

Unit IV.....	65 points
Unit II.....	54 points
Unit I.....	35 points
Unit III.....	0 points

The seventh event was the carnival relays held in the afternoon of January 17, 1932, at Manila. After running the first event, the 400 meter relay, which was won by the Los Baños team, the other three relays were defaulted to the Los Baños Unit.

The eighth event of the Inter-Section contests was baseball. This event was won by U.P. Manila defeating U.P. Los Baños in two straight games.

VII. *Athletic Dual Meets and Exhibition Games:*

In the first dual athletic meet the Los Baños Colleges on September 20, 1931, met the Philippine School of Arts and Trades on the Los Baños Colleges Athletic Grounds. The events for this dual meet were baseball, tennis, volley ball, relays and track and field. Owing to heavy rain and muddy field no event was carried out except volley ball. In this the Los Baños team won three straight sets: 21-9; 21-15; 21-11.

In the second dual athletic meet the Colleges of Los Baños met the Tayabas High School on October 24, 1931, at Lucena, Tayabas. The events were volley ball, baseball, tennis, and track and field. Volley ball was won by the high school. Out of the five events included in track and field Los Baños Colleges won four, including the relay.

The only strong baseball team available for practice for the Los Baños squad was the Canlubang Sugar Estate team. On July 25 the Canlubang team invited the Los Baños team for the first practice game at Canlubang. The score was close, 4-5 with the Los Baños team victors. The following Sunday another game was played at Canlubang, but because of rain the game had to be called off after three innings.

The strong Nomads Soccer team from Manila played a practice game at Los Baños Colleges against the local soccer squad. The score was 4-1 with the Nomads the winners.

VARSIITY LETTER MEN

Major Sports

Baseball:

1. Perfecto Ocampo.....C.A. (Junior)
2. Emmanuel Elayda.....F.S.

Basket ball:

1. Briccio Reynoso.....C.A. (Senior)
2. Julito Marcos.....C.A. (Senior)
3. Romulo Payawal.....C.A. (Freshman)

Football:

1. Antonio Flores.....C.A. (Junior)
2. José Utzurum.....C.A. (Senior)
3. Emilio Larlar.....Rural High School

Track and Field:

1. Pedro Yatar.....C.A. (Junior)
2. Pedro Lorenzo.....C.A. (Junior)
3. Amado Paggao.....C.A. (Senior)
4. Guillermo Manalo.....C.A. (Sophomore)

Minor Sports

Volley ball:

1. Marcos Julito.....C.A. (Senior)
2. Federico Banaban.....F.S.

Boxing:

1. Adolfo Castillo.....C.A. (Junior)
2. Rodolfo Pujeda.....C.A. (Freshman)

Track and Field:

1. Domingo Mapalad.....Rural High School

COLLEGE LETTER MEN

C.A.(A); C.V.S.(V); F.S.(F); R.H.S.(R)

Briccio Reynoso.....	C.A. (Senior)	Basket ball and Soccer Football
Julito Marcos.....	C.A. (Senior)	Basket ball and Volley ball
Alberto Elefaño.....	C.A. (Junior)	Basket ball
Romulo Payawal.....	C.A. (Freshmen)	Basket ball
José Utzurum.....	C.A. (Senior)	Basket ball, Soccer Football and Tennis
José Erquiza.....	C.A. (Sophomore)	Basket ball

Avelino Bigornia.....	C.A. (Sophomore).....	Basket ball
Rafael Rocés, Jr.	C.A. (Sophomore).....	Basket ball
Conrado Veloso.....	C.A. (Junior).....	Basket ball
Felicitísimo Maceda.....	C.A. (Junior).....	Volley ball
Santiago Banilan.....	C.A. (Junior).....	Volley ball
Angel Moises.....	C.A. (Senior).....	Volley ball and Baseball
Guillermo Manalo.....	C.A. (Sophomore).....	Volley ball and Track and Field
José K. Santiago.....	C.A. (Sophomore).....	Volley ball
Raul de Arana.....	C.A. (Junior).....	Volley ball
Felipe Crisóstomo.....	C.A. (Junior).....	Volley ball
Enrique Villanueva.....	C.A. (Senior).....	Volley ball
Felix Arriola.....	C.A. (Junior).....	Volley ball
Federico Banaban.....	F.S.	Volley ball and Track and Field
Domingo Mapalad.....	R.H.S.	Volley ball and Track and Field
Hermógenes Gilbero.....	R.H.S.	Volley ball
Antonio Flores.....	C.A. (Junior).....	Soccer Football
Cero Magdaleno.....	C.A. (Junior).....	Soccer Football
Crispin Escuadra.....	C.A. (Freshmen).....	Soccer Football
Tirso Morales.....	C.A. (Freshmen).....	Soccer Football
Thuan Kom Kris.....	C.A. (Junior).....	Soccer Football
Pablo Macariola.....	C.A. (Freshmen).....	Soccer Football
Phanom Smitananda.....	C.A. (Sophomore).....	Soccer Football
Elias Sombito.....	C.A. (Senior).....	Soccer Football
José Saddul.....	C.A. (Senior).....	Soccer Football
Swasdi Viradeja.....	C.A. (Senior).....	Soccer Football and Tennis
Emilio Larlar.....	R.H.S.	Soccer Football
Saropie Basunie.....	C.A. (Junior).....	Soccer Football
Antonio Cecilio.....	C.A. (Junior).....	Soccer Football
Perfecto Ocampo.....	C.A. (Junior).....	Baseball
Máximo Cañeda.....	C.A. (Junior).....	Baseball
Claudio Adam.....	C.A. (Sophomore).....	Baseball
Adolfo Castillo.....	C.A. (Junior).....	Baseball and Boxing
Anselmo Guillen.....	C.A. (Junior).....	Baseball and Track and Field
Emmanuel Elayda.....	F.S.	Baseball
Bonifacio Palos.....	F.S.	Baseball
Tomás Galgala.....	F.S.	Baseball
Floriño Guirnela.....	F.S.	Baseball
Albino Varona.....	C.A. (Senior).....	Tennis
Dominador Clemente.....	C.A. (Junior).....	Tennis
Ceferino Magno.....	C.A. (Senior).....	Tennis and Track and Field
Osmondo Modoñedo.....	C.A. (Junior).....	Tennis
Rodolfo Pujeda.....	C.A. (Freshmen).....	Boxing
Ceferino Maypa.....	C.A. (Sophomore).....	Boxing and Track and Field
Miguel Alba.....	C.A. (Junior).....	Boxing
Francisco Sevileno.....	C.A. (Senior).....	Boxing
Ricardo Estrella.....	F.S.	Boxing
Pedro Yatar.....	C.A. (Junior).....	Track and Field

Pedro Lorenzo.....	C.A. (Junior).....	Track and Field
Theodore Schuck.....	C.A. (Junior).....	Track and Field
Amado Paggao.....	C.A. (Senior).....	Track and Field
Roberto Tirol.....	C.A. (Senior).....	Track and Field
Domingo Gapuz.....	C.V.S.	Track and Field
Rufino Gapuz.....	C.V.S.	Track and Field
Florentino Fontanilla.....	F.S.	Track and Field
Patricio Valenzuela.....	F.S.	Track and Field
Longinos Espinosa.....	F.S.	Track and Field

MEDALS AWARDED

*N.C.A.A. (National Collegiate Athletic Association)**Carnival Relays*

1,600-Meter Relay:

Second Place—

1. Pedro Yatar.....C.A.
2. Amado Paggao.....C.A.
3. Pedro Lorenzo.....C.A.
4. Theodore Schuck.....C.A.

400-Meter Relay:

Second place—

1. Amado Paggao.....C.A.
2. Pedro Lorenzo.....C.A.

Sprint Medley Relay:

Second Place—

1. Amado Paggao.....C.A.
2. Pedro Lorenzo.....C.A.

Long Distance Medley Relay:

First place—

1. Pedro Yatar.....C.A.
2. Pedro Lorenzo.....C.A.
3. Theodore Schuck.....C.A.

Track and Field

400-Meter Run:

First place.....Pedro Yatar.....C.A.

1,500-Meter Run:

1. Pedro Yatar.....C.A.
2. Pedro Lorenzo.....C.A.

Discus Throw:

1. Domingo Mapalad.....C.A.
2. Guillermo Manalo.....C.A.

400-Meter Hurdles:

Second place.....Amado Paggao.....C.A.

P.A.A.F. (Philippine Amateur Athletic Federation)

800-Meter Run:

First place.....Pedro Yatar.....C.A.

1,500-Meter Run:

Third place.....Pedro Yatar.....C.A.

400-Meter Hurdles:

Third place.....Amado Paggao.....C.A.

Relays

1,600-Meter Relay:

First place.....Pedro Lorenzo.....C.A.

U. P. INTER-SECTION BOXING

1. Flyweight division:

Winner, Adolfo Castillo.....Silver buckle belt

2. Bantam weight division

Winner, Rodolfo Pujeda.....Silver buckle belt

3. Light weight division:

Winner, Ceferino F. Maypa.....Silver buckle belt

THE ROMANCE OF QUININE¹

In man's medicine chest, quinine occupies a place of peculiar distinction. It is the only known specific remedy for malaria, a disease which keeps one-third of the world's population or about 650,000,000 individuals partially or wholly incapacitated for work or play.

Romance is not confined to the entity, man, though in his egoism he is apt to feature himself as the only source or victim. Other biological forms have had their swashbucklering hours and timeless moments in gardens bathed in the light from the "lover's lamp." The white powdery quinine of the bitter taste that so swiftly "kayoes" the strength-sapping malaria germs has had its adventures.

As malaria each year kills some 20,000 Filipinos and partially incapacitates many, many thousands more, the few items of the story of quinine given here without the conventional decorations of romance should be of interest. Particularly, as the Bureau of Forestry's acclimatization of cinchona in Bukidnon was given front page prominence in the press for a few days recently. Thus recalling that quinine is not a drug store product.

There is much hullabaloo now and then about cutting down the importation of this and that in the Philippines. Why not consider cutting down the importation of quinine? And what is even more vital consider making it possible for the hundreds of thousands of malaria victims to get the only remedy. For here lies the tragedy—not the romance of quinine. To effectively combat malaria in the world, 26,000 tons of quinine would be required and only about 600 tons are produced, about two per cent of the requirement. Of this amount not a gram is grown in the Philippines, though, supposedly, the "quinine" tree would find it a home to its liking.

Some 330 years ago some Jesuit priests in Peru, probably observing the Indians using as a medicine the bark of a certain tree, discovered it had effective power over chills and fever. The first fever patient of sufficient note to make treatment with this bark a matter of record was Don Francisco Lopez de Cañizares, corregidor of Loxa in Peru. In 1630 he was cured with doses of the powdered bark. Eight years later, Countess of Chinchona, wife of the Viceroy of Peru, was very ill with ague (today it would be diagnosed as malaria). Don Francisco sent her a package of the magic-working powdered bark. In 1640 when the Countess returned to

¹General contribution from the College of Agriculture No. 310.

Spain she took a goodly supply of the bark with her. Evidently, she had a flair for advertising, for its virtues were soon known in other parts of Europe. Possibly, she used her own portrait to show contrast between "before and after taking." Whatever the method it was successful for Linnaeus a century later named the genus of the tree bearing this bark *Cinchona*. Probably he knew the name of the lady only through hearing it spoken for he left out the *h* in the first syllable—and, as with most errors, the omission has persisted.

Gomez, a Portuguese, isolated the febrifuge principle of cinchona bark in 1816. But the actual discovery and isolation of quinine was made four years later by Pelletier and Caventon, French chemists. The first sulfate of quinine, the common form, was made in the United States in 1823 by the firm, Powers and Weightman.

But the most adventurous exciting part of the romance of quinine is with the tree rather than the drug. Peru was its native home, but naturally, Europeans wished to add the tree to their gardens. A French botanist, La Condamine, attempted to take plants to Europe but after caring for his collection for eight months, he lost the plants in the Amazon River. Jussien, another Frenchman after working hard for fifteen years collecting and testing, was on his way home feeling assured of success. He guarded his collection, as can well be understood, with zealous care. A native, noting this, stole the box, feeling sure only gold would be so guarded. Losing his collection so affected the botanist that he became insane.

The rapidly growing demand for the cinchona bark combined with unsuccessful efforts to transplant the tree could have but one result—the great reduction of the supply and the increase in price. It is recorded that by the middle of the last century quinine was quoted at \$20 (£40) an ounce.

About this time, England enters the list in the quinine tournament. Malaria, of course, was still annually claiming its hundreds of thousands. No quinine could be secured. A part of India was tropical. Clements Markham was a clerk in the Indian office in London. He had been in Peru. In 1860, he suggested transplanting the cinchona tree in India. He was appointed head of a small expedition with the botanist, Spruce, as assistant to go to Peru, get cinchona seeds and plants if possible. The Peruvians had begun to realize the importance of holding on to their monopoly. Markham knew this. Hence, he worked as secretly and as expeditiously as possible. But soon he knew he was suspected. He got what seeds he could as speedily as he could. From one village, only a quick exit saved him. Flourishing revolvers—loaded with damp ammunition—saved the day in another village. After many episodes, Markham's expedition reached the sea. Just as he was getting in the boat to row to the ship he was told that one of the boatmen had been bribed to pour boiling water

on his collection. Being forewarned, Markham saw that this scalding scheme came to naught.

The precious seeds were finally planted in Kew Gardens. Seeds from these plants were later sown in Neilgherry Hills, India. By 1880, the plantations were bringing in a good revenue to the government—and quinine could be bought in India for a few pence an ounce, the ultimate good desired. Markham, the last of the cinchona crusading knights, died in 1916.

The Dutch, the seventh nation to enter the lists, came in when adventure was confined to the laboratory and the nursery. Nevertheless, Java might not today be supplying 98 per cent or more of the quinine consumed in the world from her 25,000 or 30,000 acres of plantation had it not been for Van Leersum who for the first twenty-five years or more after the introduction never left the work for even a holiday out of Java. No romantic adventure his, but a cinchona knight, nevertheless.

EMMA S. YULE

Of the Department of English

Education is not to teach men facts, theories or laws; it is not to inform them or amuse them or make them expert technicians in any field; it is to teach them to think, to think straight if possible; but think always for themselves.—ROBERT MAYNARD HUTCHINS, *President, University of Chicago*.

More intelligent and scientific farming, more farmers raising their own vegetables and fruits, producing their own dairy products, raising cattle, hogs, sheep, and poultry, and at least living from the products of their own farms—that is the solution to the problem for thousands of farmers. Difficult as his situation is, if the farmer will give up looking for legislative palliatives and tend strictly to business, he can make a fair living even in years of low prices such as this, and be in a much more satisfactory position than many of his city brethren.

—*Review of Reviews*, August, 1931.

TWO FUNGOUS INVASIONS OFTEN FOLLOWING THE COCONUT LEAF MINER, PROMECOTHECA CUMINGII BALY¹

F. L. STEVENS

Charles Fuller Baker Memorial Professor (1930-1931) of Plant Pathology

WITH TWO TEXT FIGURES

THE GRAY SPOT

The gray spot of coconut (*Cocos nucifera* L.) caused by *Pestalozzia palmarum* Cke. has been well described and illustrated by Cortez,² who cites twelve articles regarding it which appeared between 1889 and 1928 from the Philippines, Peradeniya, Cuba and England. Thirty-five articles bearing upon this disease are listed by Basilio Hernandez as available in the Bureau of Science Library in Manila.

The following brief description is here given to enable comparison with the *Epicoccum* spot. The most typical spot is oval or irregularly oval, the longest diameter resting lengthwise of the leaf. The most usual size is about 12×6 mm., but occasionally reaching to 18 mm. long or by coalescence of several spots involving much larger areas.

At maturity the spot on its upper surface is usually a dull silver color

and is heavily studded with black specks, the acervuli of the fungus; the blackness is due to rupturing of the silvery epidermis thus uncovering the

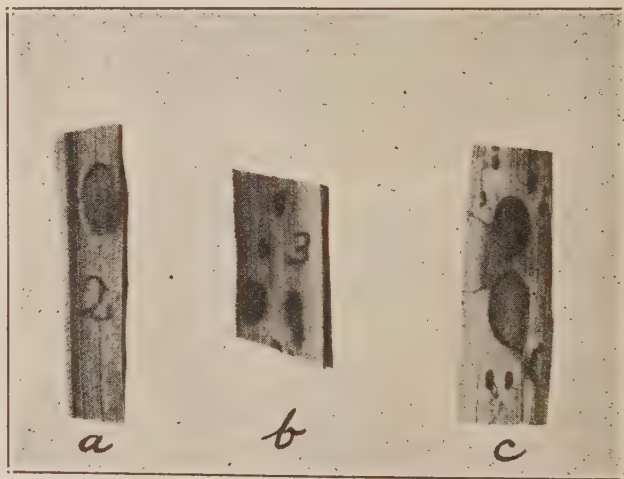


Fig. 1. a. A spot of *Pestalozzia palmarum* Cke. showing signs of the parasitized larva in the center. b. Four spots of *Epicoccum cocos* Stevens of different ages. c. The six small spots are due to *Epicoccum cocos* Stevens; the three large ones to *Pestalozzia palmarum* Cke.

¹Experiment Station contribution No. 817. Received for publication May 6, 1932.

²THE PHILIPPINE AGRICULTURIST 17: 223-235. 1928.

mass of black spores beneath. The acervuli may be punctiform or considerably elongated and the rifts correspondingly minute and stellate or linear, suggesting the *Hysteriales* in general aspect. In some instances, not common, the upper surface remains tan colored and without acervuli and the acervuli are produced on the lower tan colored surface.

These circular spots (fig. 1a) are very frequently centered around a wound due to oviposition of the leaf miner, *Promecotheca cumingii* Baly and subsequent parasitization of the egg or larva, though such is not always the case. In younger spots, or spots in arrested development, the upper surface is tan colored and acervuli may be quite absent or few in number.

The lower surface of the spots is tan colored and shows no acervuli. The spots are in all cases very definitely bordered by a slightly raised honey yellow rim that very evidently marks the host's resistance to further invasion (fig. 1a and c).

A second type of leaf spot that is due to *Pestalozzia* is that in which invasion occurs through wounds of the leaf miner channels. These spots are rectangular and of greater or lesser extent. They show the surface and border characteristics of the oval spots.

THE EPICOCCUM SPOT

These spots are very numerous but since many of them remain small they do not occupy nearly so much of the leaf area as do the *Pestalozzia* spots. The larger of them are about the size of the *Pestalozzia* spots, 18×6 mm. Very numerous small ones also occur, 2×3 mm.

The spots are dark tan color to brown above and below and are bordered by a brown line (fig. 1b and c).

The sporodochia when mature are black. They are most common hypophyllous but occasionally are epiphyllous. They are frequently unequally distributed over the spot, occurring in dense clumps at one or both edges, or near the center. In young spots the sporiferous area is often rectangular being limited by two veins.



Fig. 2.—A portion of the conidiophore and a conidium of *Epicoccum cocos* Stevens.

Infection often occurs through wounds caused by insects though often also such injuries are not evident.

In the affected region more than half of the stomata are occupied by sporodochia and the tissue beneath is densely packed with mycelium.

The species appears to be undescribed, therefore the following:

Epicoccum cocos n. sp.

Conidia brown, continuous, smooth, globose to ovate and slightly pointed at one end, 3μ in diameter or when ovate $3\times 6\mu$. Conidiophores septate much branched and forming by union of their bases a pseudo-parenchymatous central region of the sporodochium. Conidia terminal on short branches (fig. 2). Sporodochia black, globose or somewhat flattened, sessile except for the short stalk emerging from the stomata, exostomatal $75-120\mu$ in diameter.

On *Cocos nucifera*

College of Agriculture, Leaf Miner Field Station, Imoc near kilometer No. 82 between Calauan and San Pablo, Luzon, P. I.

Specimen No. 136 (type) July 29, 1930. F. L. Stevens.

A MICROBIOLOGICAL STUDY OF FOREST AND NON-FOREST SOILS AT THE COLLEGE OF AGRICULTURE¹

DIONISIO I. AQUINO²
Of the Department of Soils

WITH TWO TEXT FIGURES

The potential crop production of the soil or its fertility depends largely upon its physical, chemical and biological properties. These properties may include texture, moisture content, aëration, reaction, plant nutrients and the enormous numbers of microörganisms which play an important rôle in several biological processes which result in the transformation of various complex substances from insoluble forms so that they can be well utilized by the plants.

Numerous studies have been made on the influence on the numbers and physiological behavior of the soil population of different systems of cropping and fertilizer applications. The results secured in these studies vary, mainly because of the effect of variations in the soil conditions under which the investigations were carried. It appears, however, from some recent studies that some forms of crop rotation, cultivation, manure application, partial sterilization and lime addition influence not only the very occurrence and abundance of various specific forms of microscopic organisms which inhabit the soil, but also tend to stimulate their development and activities.

REVIEW OF THE LITERATURE

An excellent review of the literature on this subject is presented in a book by S. A. Waksman (1927). In this paper reference will be made only to those studies which are directly related to the present investigation.

The work of Neller (1920), Noyes and Conner (1919), Brown (1913) and Waksman (1922) suggested that the determination of the number of microörganisms in the soil by the plate method, with due allowance for the variability of the methods employed and for the kind of soils, may serve as a means for measuring the bacterial condition of the soil and its potential fertility. These investigators claimed that a definite correlation was found to exist between crop yield, oxidizing capacity of soil, production

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²The writer wishes to acknowledge his indebtedness to Dr. R. L. Pendleton, Head, Department of Soils, who suggested the problem and to Professor H. M. Curran of the School of Forestry for his valuable help during the progress of the work.

of nitrate and bacterial counts, but not between crop yield and the ability of the soil to produce ammonia.

Erdman and Humfeld (1928) stated that when ammonium sulfate was used in the nitrification test there was a correlation between the crop yields, nitrifying power and the soil reaction after a period of incubation.

Pañganiban (1915) expressed the belief that the activities of bacterial flora of the soil were influenced by the present and the preceding crops grown. The addition of 25 per cent of sand to the clay soil which he used in his nitrification experiment resulted in the rate of nitrate production increasing to as high as 80 per cent.

The results of the work of Allen and Bonazzi (1915) showed that the nitrifying power of a soil may or may not be correlated with its ability to produce crops. These authors further claimed that continuous cropping without an application of fertilizers reduced the nitrifying efficiency of the soil. They attributed this reduction to the lack of specific groups of organisms in the soil and to the absence of those favorable conditions which may tend to stimulate the growth and reproduction of the soil microflora.

Alicante (1926) emphasized the importance of biological study of the soil. He stated that the only way by which the complex organic materials can be transformed into a form available for the plants is by the action of the soil organisms. "Therefore", he said, "for all important unproductive agricultural lands it is advisable that biological analysis, as well as chemical and physical analysis, be made."

OBJECTS OF THE PRESENT WORK

This study was made to secure some data which may throw additional light on the common occurrence and numbers of microorganisms in forest and non-forest soils; and to point out some possible correlation between the bacterial and mold counts, the moisture content, the soil reaction, nitrification and nitrifying efficiency of the soils under investigation.

THE SOIL STUDIES

In an attempt to study the changes which occur in the native soil microflora, samples were collected from the surface soils in and about the commercial forest on Faculty Hill near Dean Gonzalez's residence. Also from an adjacent non-forest area on the Campus of the College of Agriculture.

The commercial forest occupies an area of 1.2 hectares on which plots 1, 2, 3 and 4 were laid off. The first two plots are located on a portion which is entirely covered with lanutan I, *Bombycidendron campylosiphon* (Turcz.) Warb. (Malvaceae). This area is characterized by having a uniformly sloping surface.

Plots 3 and 4 are located on an area which has a few slight depressions where a moderate amount of plant remains have accumulated. This portion of the forest is entirely covered with lumbáng, *Aleurites moluccana*

(L.) Willd. (Euphorbiaceae) which is grown for oil production. Between and under the trees the ground is sparsely covered with other species of plants. In some places *Paspalum* sp. grows. The southeastern portion of this area is characterized by a little denser vegetation and a few small seedlings of ipil-ipil, *Leucaena glauca* (L.) Benth. (Leguminosae) are found.

The adjacent non-forest soil represents plot 5 in this study. This portion is on a leveler area and is located just southwest of the commercial forest. This plot has an area of 0.24 hectare and is covered by cogon, *Imperata cylindrica* Linn. (Graminae).

PHYSICAL CHARACTERISTICS

The physical characters of the soils showed no little variation. These soils may be classified as clay loam.

The surface soil is dark to dark grayish brown with a moderate amount of organic matter. Its structure is friable and loose. An examination of the subsoil showed that it is clay loam the color ranging from brown to reddish brown; and the structure is heavy. The general topography is sloping and the drainage is good.

Method of soil sampling

The first sampling was made on October 2, 1930. It was originally planned to make bi-weekly samplings during the progress of the work, but owing to unfavorable weather conditions, this plan was not carried out. The dates of samplings are shown in table 1.

At regular intervals, soil samples were collected from five different plots. With a trowel, the surface soil was removed from an area of fifteen to twenty centimeters square. The soil was stirred to a depth of about fifteen centimeters, then the samples were taken. Twelve samples of small amounts were secured in this manner and mixed thoroughly to form composite samples. These were placed in mason jars, covered, labeled and then taken to the soils laboratory where different tests were performed.

Quantitative determination of the number of bacteria in the soil

The number of bacteria in the soil was determined by the usual plate method, using the "modified albumen" agar medium of Brown (1913). The composition of the medium is as follows:

Dextrose.....	10.0 grams
Dipotassium phosphate.....	0.5 gram
Magnesium sulfate.....	0.2 gram
Ferric sulfate.....	Trace
Egg albumen.....	0.25 gram
Agar.....	15.0 grams
Distilled water.....	1,000.0 cc.

The egg albumen was dissolved in a little amount of cold water. A few drops of sodium hydroxide solution were added and this was mixed with the hot medium which had been prepared. The reaction was adjusted to pH 7.0.

Ten cc. portions of the medium were pipetted into the test tubes, plugged with cotton and sterilized in the autoclave at fifteen pounds pressure for about twenty minutes. The bacteria were brought into suspension by shaking fifty grams of soil in a flask containing 500 cc. of sterile water. By means of sterile pipettes, used for each transfer, the following dilutions were made:

- (a) 10 cc. of the infusion in 90 cc. sterile water: dilution equals 1:100.
- (b) 10 cc. of (a) in 90 cc. sterile water: dilution equals 1:1,000.
- (c) 10 cc. of (b) in 90 cc. of sterile water: dilution equals 1:10,000.
- (d) 10 cc. of (c) in 90 cc. sterile water: dilution equals 1:100,000.

After shaking thoroughly, one cc. portions of dilution (d) were transferred to each of the four petri dishes. Then 10 cc. of Brown's agar medium were poured into each of the dishes. The plates were incubated in an inverted position at room temperature for one week, then the bacterial colonies were counted. The numbers of colonies secured on the four plates were averaged. Table 1 presents the bacterial counts.

Quantitative determination of the number of molds in the soil

The number of molds was determined by the use of Waksman's synthetic acid agar medium (1922) which was prepared as follows:

Glucose.....	10.0 grams
Peptone.....	5.0 grams
Monopotassium phosphate.....	1.0 gram
Magnesium sulfate.....	0.5 gram
Agar.....	25.0 grams
Distilled water.....	1,000.0 cc.

The various ingredients were dissolved in the water, and the final reaction was adjusted to a pH of 4.0 by the addition of normal solution of sulfuric acid.

Following the same method of procedure as was employed in the preparation of infusion and dilutions used in the counting of the bacterial numbers, one cc. portions of dilution (c) representing 1:10,000 were transferred to each of the four sterile petri dishes. The medium was added and the plates were kept at room temperature for three days. The results of the determination of the number of molds in the soil are given in table 2.

The moisture determination and the soil reaction were also recorded and the results are presented in table 3.

Nitrification of ammonium sulfate with and without calcium carbonate

In this experiment, soil samples, each equivalent to 100 grams of air-dry soil were weighed out and placed in glass tumblers. Thirty mgm. of nitrogen as ammonium sulfate alone and with calcium carbonate (210 mgm.) were added to duplicate tumblers. The tumblers were covered with tin covers and incubated at ordinary room temperature for four weeks at a moisture content of fifty per cent saturation. At the end of every ninth

day during the period of incubation, each sample was stirred and an amount of distilled water equal to that which had been lost by evaporation was added so as to maintain an optimum moisture condition. Checks were carried with the tests to determine the nitrification of the soil's own nitrogen in each sample. At the end of the incubation period the nitrate nitrogen contents of the samples were determined by the phenoldisulfonic acid method. By the use of the following formula, suggested by Emerson (1925), the amount of the nitrate was calculated as milligrams of nitrogen as nitrate per 100 grams of air-dry soil.

$$\times = \frac{100}{W} \cdot \frac{S}{A} \cdot d \cdot \frac{K}{U} \cdot M$$

Where:

X = mgm. of nitrogen as nitrate per 100 grams dry soil.

W = weight of dry soil.

S = cc. of water added to the soil (W).

A = aliquot taken for evaporation.

D = cc. to which A is diluted.

K = reading in mm. of standard solution.

U = reading in mm. of unknown solution.

M = mgm. of nitrate nitrogen in 1 cc. of standard solution as diluted for reading.

Nitrification of other inorganic salts

This experiment was conducted with the object of comparing the nitrifying capacity of the various soils. Three inorganic nitrifiable salts; namely, ammonium chloride, ammonium carbonate and ammonium phosphate, were used in this experiment.

The method employed in the nitrification experiment was employed and the different salts were added to the cultures in form of solution.

The results obtained by the use of above formula are presented in table 5.

DISCUSSION OF RESULTS

That there is an enormous number of microorganisms in the soil is clearly shown by the results secured. In this work, attempts were made to obtain some information concerning the common occurrence and numbers of bacteria and molds in forest and non-forest soils. The possible correlation between the bacterial and mold numbers, moisture content, soil reaction, nitrification and nitrifying efficiency of the soils used in the tests may be brought about by the data herein presented.

Table 1 presents the data obtained in all determinations of the numbers of bacteria and molds which inhabit the soil.

The number of molds secured at the different periods of sampling is presented in table 2.

The data shown in table 3 indicate the moisture contents and the reactions (pH values) of the soils.

Examination of the data given in tables 1 and 2 and illustrated in the graph (fig. 1) showed that there was a considerable fluctuation in the

bacterial and mold numbers at different dates of sampling. The occurrence of the bacteria and the molds in the soils of the five plots was compared and it appeared that there was apparently no relation between the number of bacteria and of molds. The number of molds fluctuated with no apparent connection with the bacterial counts. This phenomenon seemed to suggest that some conditions other than moisture, reaction, and some external factors might have exerted a controlling influence on the activities of the bacteria and the molds. It may also be microörganic in nature or at least chemical conditions may be responsible for this result. In other words, some factor which is not yet identified probably accounts for this fluctuation.

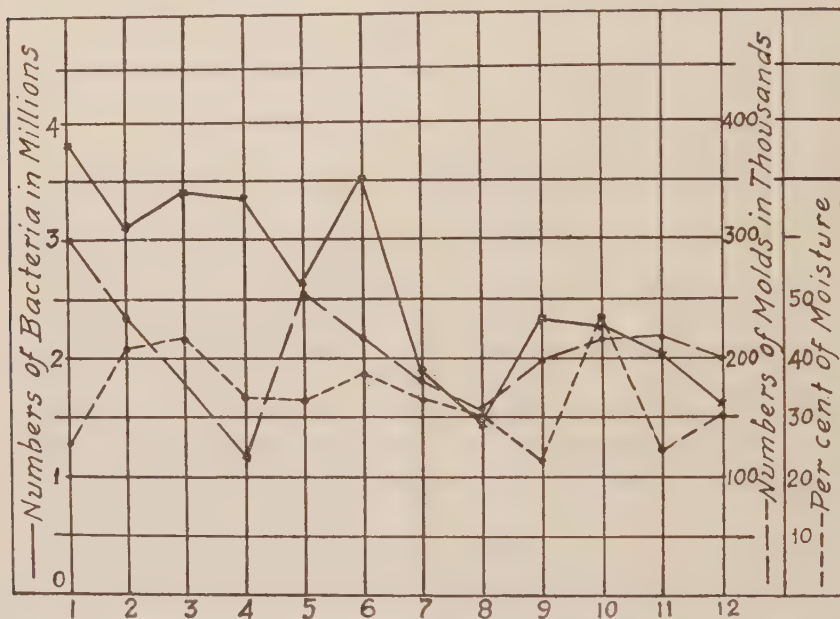


Fig. 1.—Showing the average number of bacteria and molds, and the moisture content of the soils at various dates of sampling.

Figure 2 which is a graphical summary of the data given in tables 1 and 2 indicates that the different plots from which the soil samples were secured varied rather distinctly with respect to the numbers of soil micro-organisms. This variation may be attributed to the different methods of soil management, kind of crops, stage of the growth of crops, the difference in seasonal conditions and the topography of the land.

The results secured from the determination of the moisture content of the soil at different sampling periods, as illustrated in figure 1, showed that there was a considerable fluctuation of the percentage of moisture present at various dates of sampling. It may also be seen that, in general,

there seemed to be a favorable influence of increase in moisture upon the number of bacteria. When the average total moisture content of the soils from the different plots, as shown in figure 2, is considered, it may be stated that the percentages of moisture showed a slight variation. Plot 5, where cogon, *Imperata cylindrica* Linn. was allowed to grow and then cut, showed a greater amount of moisture than any of the other plots. This condition seemed to indicate that cogon, when cut and allowed to remain on the surface of the ground, would tend to prevent the loss of soil moisture through the process of evaporation.

The data presented in table 3 reveal that there was no significant variation of the soil reactions as measured by the use of the quinhydrone

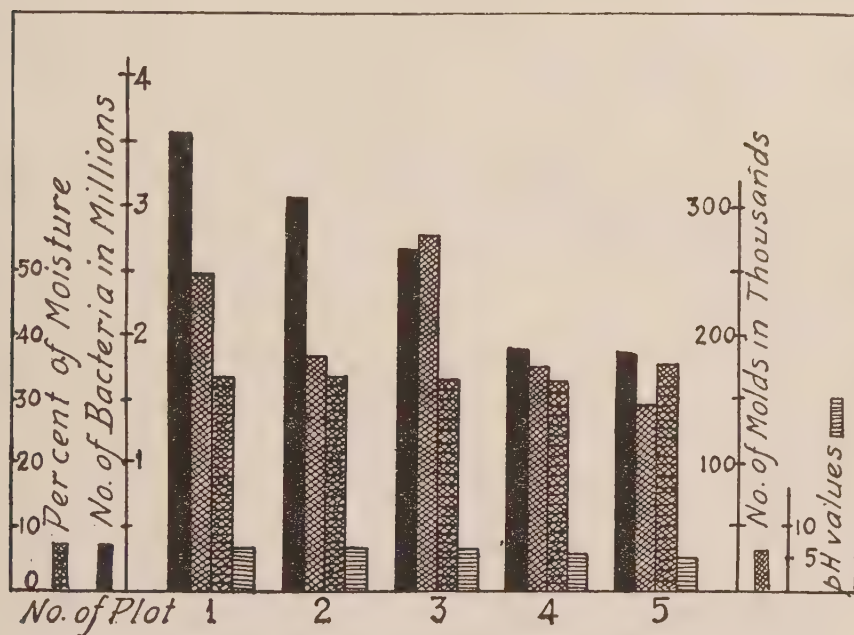


Fig. 2.—Showing the relation of the number of bacteria and molds, percentage of moisture and the soil reactions (pH value) in the soil from each of the five plots.

pH indicator at different dates of sampling. There was, however, a slight difference of the pH values of the soils from each of the five plots. The average pH value of the soil from plot 1 was 6.12; plot 2 showed an average pH value of 6.02. Plot 3 indicated an average pH value of 6.08; pH 5.94 was shown by soil from plot 4 and plot 5; the non-forested area had an average pH value of 5.80.

The average figures given in table 4 showed that the soils varied in their ability to nitrify ammonium sulfate. The soils from the forested area showed a greater nitrifying power than those from the non-forested area. The nitrification of ammonium sulfate in all soils collected from

the different plots was more marked when calcium carbonate was added in a sufficient amount to neutralize the acids which were formed by the complete oxidation of the ammonium sulfate. This finding is in accord with the results secured by Aragon (1918) and Brown and Aquino (1929).

The results of the nitrifying efficiency tests given in table 5 showed that the soils differed in their ability to nitrify the ammonium salt. A greater nitrifying power was shown by the forest soils than by the non-forest. It is of interest to note that the largest amount of nitrate nitrogen was obtained from the use of the ammonium phosphate, the next largest was from the ammonium carbonate treatment and the least was secured from the addition of ammonium chloride.

An examination of all the average results on the determination of the nitrate nitrogen contents of all the cultures that were marked check, as shown in tables 4 and 5, showed that the forest soils had a greater amount of nitrate nitrogen than the non-forest soils.

SUMMARY OF CONCLUSIONS

1. The numbers of the microorganisms which occurred in the soils studied fluctuated during the different periods of sampling. This finding is attributed to the varied methods of soil management, kind of crops grown, stage of the growth of the crops, seasonal conditions and perhaps to the topography of the land.

2. Bacterial numbers showed no apparent relation with the number of molds in the soil. The numbers of molds fluctuated without regard to the bacterial counts. This phenomenon is probably due to the existence of some conditions other than moisture, reaction and some external factors which might have exerted a controlling influence on the activities of either bacteria or molds during a certain period of sampling. It may also be suggested that the fluctuation of the bacterial and mold counts was probably due to other biological and chemical conditions in the soil.

3. A considerable variation of the moisture contents of the soils at various times of sampling was observed.

4. The moisture of the soil showed a favorable influence upon the bacterial numbers. The molds, however, were apparently unaffected by moisture.

5. The reactions of the soil showed no marked influence on bacterial activity.

6. The forest soils showed a greater amount of nitrate nitrogen than the non-forest soils. This difference is shown by the average results on the determination of the nitrate nitrogen contents of all the cultures that were marked check, as given in tables 4 and 5.

7. A correlation was found to exist between the production of nitrate nitrogen and the bacterial counts in all soils studied.

8. The nitrifying power and the bacterial content of the soil may be correlated.

9. A more active nitrification took place in forest soils than in the samples collected from the non-forest area.

10. Calcium carbonate when added to the soil stimulated the process of nitrification.

11. All the soils used in the nitrifying efficiency tests showed their highest average gains in nitrate nitrogen from the use of ammonium phosphate, the next highest from the ammonium carbonate and the least from the use of ammonium chloride.

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TABLE 1
Number of bacteria per gram of air-dry soil

PLOT NO.	DATES OF SAMPLING											Average
	Oct. 2, 1930	Oct. 18, 1930	Nov. 1, 1930	Nov. 15, 1930	Nov. 29, 1930	Dec. 20, 1930	Jan. 10, 1931	Jan. 24, 1931	Feb. 7, 1931	Feb. 24, 1931	March 14, 1931	March 31, 1931
I.	4,736,900	4,674,700	4,350,000	4,440,000	3,921,600	5,050,000	3,204,000	2,050,000	3,305,000	3,050,000	2,000,500	2,075,000
II.	3,010,000	3,295,000	3,390,000	2,400,000	2,350,000	4,600,000	3,005,000	2,130,000	3,125,000	3,250,000	3,050,000	3,000,500
III.	5,284,000	3,458,000	3,350,000	3,980,000	3,025,500	3,305,000	1,205,000	1,040,000	2,063,000	2,050,000	2,005,000	1,075,000
IV.	2,267,000	2,662,700	2,504,000	2,401,000	1,805,000	2,005,000	1,050,000	1,030,000	2,003,000	1,900,000	2,050,000	1,050,000
V.	3,618,000	1,416,400	3,500,000	3,607,000	2,002,500	2,600,000	985,000	980,000	1,075,000	1,050,000	995,000	885,000
Average.	3,803,380	3,101,360	3,418,800	3,365,780	2,620,920	3,512,000	1,889,800	1,454,000	2,315,000	2,260,000	2,020,100	1,617,100

TABLE 2
Number of molds per gram of air-dry soil

PLOT NO.	DATES OF SAMPLING											Average
	Oct. 2, 1930	Oct. 18, 1930	Nov. 1, 1930	Nov. 15, 1930	Nov. 29, 1930	Dec. 20, 1930	Jan. 10, 1931	Jan. 24, 1931	Feb. 7, 1931	Feb. 24, 1931	March 14, 1931	March 31, 1931
I.	310,000	169,970	120,800	126,800	370,500	352,000	232,000	210,000	205,000	300,500	275,000	300,000
II.	250,000	202,000	158,500	93,300	99,700	105,000	125,000	115,000	215,000	250,000	300,500	275,000
III.	359,000	134,960	212,750	212,760	438,500	325,000	295,000	225,000	300,000	300,000	275,000	209,000
IV.	226,700	458,500	313,000	98,870	221,600	98,000	85,000	79,000	120,000	105,000	150,000	130,000
V.	362,000	198,300	98,500	53,830	146,400	202,000	165,000	155,000	125,000	55,000	95,000	85,000
Average.	301,540	232,746	180,710	117,112	255,340	216,400	180,400	156,800	193,000	212,100	219,100	199,500

TABLE 3
Showing the percentage of moisture and the pH values of the soil

PLOT NO.	DATES OF SAMPLING														AVERAGE REACTION (pH)	AVERAGE PERCENT H ₂ O				
	October 2, 1930	Oct. 18, 1930	Nov. 1, 1930 ^a	November 15, 1930		Nov. 29, 1930 ^b	December 20, 1930		January 10, 1931	January 24, 1931	February 7, 1931 ^c		March 14, 1931	March 31, 1931						
				Reaction (pH)	Percentage of moisture		Reaction (pH)	Percentage of moisture			Reaction (pH)	Percentage of moisture		Reaction (pH)			Percentage of moisture			
I.	6.31	24.52	42.40	41.64	6.51	34.28	30.65	6.30	35.14	28.87	5.80	34.78	20.16	6.02	45.77	23.46	5.80	30.72	32.69	6.12
II.	6.17	25.00	40.20	43.30	6.25	33.33	35.50	6.00	35.12	31.23	6.00	28.53	19.62	5.90	47.70	19.05	5.82	33.14	32.72	6.02
III.	6.12	28.20	36.00	49.92	6.50	32.94	30.30	6.00	34.05	34.41	5.90	26.58	21.63	6.00	44.93	22.55	6.00	27.71	32.43	6.08
IV.	5.80	25.94	38.80	41.93	6.10	30.30	32.40	6.05	38.66	31.24	6.00	28.53	25.00	5.80	47.74	25.94	5.90	30.05	32.21	5.94
V.	6.11	24.68	38.50	41.64	5.82	34.58	33.60	5.70	40.84	42.45	5.70	33.33	25.31	5.60	46.88	29.53	5.80	29.70	35.08	5.80
Average ..	6.10	25.67	41.88	43.81	6.24	33.08	32.59	6.22	36.76	33.64	5.88	30.35	22.34	5.72	46.50	24.11	5.82	30.26		

Observations:

- ^aThird sampling, cogon, cut.
- ^bFifth sampling, cogon, luxuriantly growing.
- ^cTenth sampling cogon, cut.
- ^dTwo days before the last sampling, heavy rain occurred.

TABLE 4

Showing the nitrification of ammonium sulfate with and without calcium carbonate

PLOT NO.	TUMBLER NO.	TREATMENT		MGM. NITROGEN AS NITRATE IN 100 GRAMS AIR DRY SOIL					
		(NH ₄) ₂ SO ₄ 30 mgm. N	CaCO ₃ 210 mgm.	First set		Second set		Third set	
					av.		av.		av.
I	1	None	None	0.42		0.48		0.40	
	2	"	"	0.40	0.41	0.46	0.47	0.38	0.39
	3	(NH ₄) ₂ SO ₄	"	4.26		3.89		3.08	
	4	"	"	4.17	4.21	3.91	3.90	3.18	3.13
	5	"	CaCO ₃	4.37		4.33		4.00	
	6	"	"	4.41	4.39	4.37	4.35	4.05	4.02
II	7	None	None	0.40		0.47		0.42	
	8	"	"	0.38	0.39	0.49	0.48	0.38	0.40
	9	(NH ₄) ₂ SO ₄	"	4.02		3.75		3.00	
	10	"	"	3.88	3.95	3.73	3.74	3.08	3.04
	11	"	CaCO ₃	4.28		4.00		3.70	
	12	"	"	4.18	4.23	4.05	4.02	3.14	3.42
III	13	None	None	0.40		0.46		0.36	
	14	"	"	0.37	0.38	0.49	0.47	0.38	0.37
	15	(NH ₄) ₂ SO ₄	"	4.14		4.47		3.02	
	16	"	"	4.18	4.16	4.05	4.26	3.02	3.01
	17	"	CaCO ₃	4.41		4.57		3.33	
	18	"	"	4.59	4.45	4.47	4.65	3.80	3.56
IV	19	None	None	0.43		0.31		0.36	
	20	"	"	0.45	0.44	0.30	0.30	0.34	0.35
	21	(NH ₄) ₂ SO ₄	"	3.33		2.93		2.03	
	22	"	"	3.32	3.32	2.70	2.81	2.60	2.31
	23	"	CaCO ₃	3.61		3.14		2.80	
	24	"	"	3.64	3.62	3.17	3.15	3.00	2.90
V	25	None	None	0.41		0.36		0.34	
	26	"	"	0.42	0.41	0.38	0.37	0.30	0.32
	27	(NH ₄) ₂ SO ₄	"	3.95		3.47		2.00	
	28	"	"	3.89	3.92	3.58	3.52	1.98	1.99
	29	"	CaCO ₃	4.26		3.62		2.60	
	30	"	"	4.37	4.31	3.62	3.62	2.42	2.51

TABLE 5
Showing the nitrifying efficiency of the soils as measured by the use of nitrifiable inorganic compounds

PLOT NO.	TUMBLER NO.	SERIES I <i>a</i>				SERIES II <i>b</i>				SERIES III <i>c</i>			
		av.	0.32	0.29	0.36	av.	0.32	0.26	0.30	av.	0.30	0.28	av.
Mgm. nitrogen as nitrate in 100 grams air dry soil													
I	1	0.40	0.32	0.29	0.36	0.32	0.26	0.30	0.30	0.28	0.28	0.28	0.28
	1-A	0.36	0.26	0.29	0.30	0.33	0.26	0.30	—	0.30	0.28	0.28	0.28
	2	2.08	1.89		3.57	3.12	3.12		3.33	3.12	3.12	3.12	3.12
	2-A	2.00	1.91	1.90	3.70	3.68	3.19		3.49	3.21	3.26	3.26	3.19
II	3	0.38	0.33		0.36	0.32			0.36	0.34		0.34	
	3-A	0.40	0.35	0.34	0.40	0.38	0.28		0.42	0.39	—	0.34	0.34
	4	1.92	1.95		3.49	2.98			3.80	3.78	3.53		3.47
	4-A	1.85	1.92	1.94	3.41	3.45	2.96		3.76	3.78	3.41		3.47
III	5	0.35	0.36		0.28	0.26			0.32	0.34		0.34	
	5-A	0.38	0.34	0.35	0.26	0.27	0.32		0.28	0.30	0.30	0.32	0.32
	6	1.85	1.82		3.57	2.68			3.41	3.41	3.57		
	6-A	1.82	1.79	1.81	3.49	3.52	2.73		—	3.41	3.41	3.49	3.49
IV	7	0.32	0.34		0.28	0.19			0.32	0.26		0.26	
	7-A	0.36	0.28	0.31	0.32	0.35	0.35		0.30	0.31	0.28	0.27	0.27
	8	1.83	1.83		3.33	3.41			3.19	3.49	3.49		
	8-A	1.79	1.84	1.83	3.26	3.30	3.33		3.33	3.26	3.33	3.41	3.41
V	9	0.36	0.32		0.32	0.40			0.30	0.30		0.30	
	9-A	0.34	0.36	0.34	0.34	0.33	0.33		0.28	0.29	0.29	0.29	0.29
	10	2.00	1.92		3.23	3.53			3.53	3.41	3.41		
	10-A	2.04	1.85	1.89	3.41	3.32	3.57		3.49	3.51	3.49	3.45	3.45

^aIn series I, 30 mgm. of nitrogen as NH_4Cl_2 solution were used.

^bIn series II, 30 mgm. of nitrogen as $(\text{NH}_4)_2\text{CO}_3$ solution were used.

^cIn series III, 30 mgm. of nitrogen as $(\text{NH}_4)_3\text{PO}_4$ solution were used.

COMPARATIVE STUDIES OF THE VALUES OF DIFFERENT MASH MIXTURES FOR EGG PRODUCTION ¹

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WITH ONE CHART

For many years, now, the standard breeding mash that is used in this College has consisted of 1 part dried shrimps, 2 parts corn meal, 3 parts copra meal and 4 parts rice bran; all by weight. A combination of some science and a lot of common sense was the only guide used in deciding on this mash mixture. If one part of this mash mixture is fed to breeders with one part of grain consisting of either equal parts of corn and palay or corn or palay alone, the ration has been found to be economical and the cost of production reasonably low. Fronda (1929) compared this ration with a laying ration in which the mash consisted of 2 parts dried shrimps, 1 part corn meal, 3 parts copra meal and 4 parts rice bran, and observed that while the birds fed with the breeding mash did not lay as many eggs as those that were fed with the laying mash, neither was the cost of production as high. The reason for the difference in the cost of production is that the cost of the standard breeding mash was lower than that of the laying mash.

Since the publication of this report by Fronda, a number of questions have come up which can not be answered from the results of any of the poultry feeding studies hitherto completed in this College. One of these questions is about the necessity of including copra meal in the ration, since it has been shown that the fowls do not find it palatable (Tuason and Fronda, 1924; Amon, 1930) and when used as a supplement in mashes for laying hens it did not favor egg production (Taleon, 1924). Also, where copra meal is not available at reasonable prices what modifications may be made in the standard breeding mash mixture of the College? In short, what would be the effect upon the egg production if the copra meal were omitted from the standard breeding mash mixture and the same amount of corn meal or rice bran be substituted?

In an attempt to find answers to these questions, the experiments here reported were conducted. While the results obtained are far from being complete, sufficient data have been secured to serve as foundation for studies that may be made along these lines later. The studies here discussed were made from September 1, 1930 to August 31, 1931.

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The stock. One hundred and seventy-five Los Baños Cantonese pullets were used in these studies. They were divided into seven lots, each lot consisting of twenty-five birds. No special attention was paid to the selection of the birds used, but the lots were made as even as possible. Except for the different factors that were under consideration, the different mash mixtures, the housing, care, methods of feeding and other environmental conditions were essentially the same in all lots.

Factors under consideration. The grain mixtures given to the different lots were the same. From September to December, 1930, the mixture was two parts of corn and one part of palay; during January and February, palay alone was given; during March and to the end of the experiment, August, 1931, the grain mixture consisted of equal parts of corn and palay. Thus, the only variable factors were the mash mixtures given to the different lots. One lot received the standard breeding mash. This lot was used as the check to which the other six mash mixtures used in the study were compared. Three sets of mash mixtures were tested. The mash mixtures given to the different lots are shown in table 1.

TABLE 1
Showing the composition of the different mashes studied

MASH NO.	DRIED SHRIMPS	CORN MEAL	COPRA MEAL	RICE BRAN ^a
1	1	2	3	4
2	1	2	0	7
3	1	5	0	4
4	2	2	0	6
5	2	0	2	6
6	2	0	0	8
7	2	8	0	0

^aA fine grade of rice bran was used in this study.

The question that mash mixtures No. 2 and 3 were to answer was: If copra meal is not available, which ingredient in the standard breeding mash may be increased, the rice bran or the corn meal? Mash mixture No. 4 is a new combination also composed of the three ingredients, dried shrimps, corn meal and rice bran. Mixture No. 5 is also a new combination in which the corn meal in mixture No. 4 was replaced, weight for weight, by copra meal. Mash mixtures No. 6 and 7 are the simplest mash mixtures that can possibly be used under general farm conditions in the Islands; in No. 6 rice bran is the base, in No. 7, corn meal. From this point on, these mash mixtures will be designated by the amounts of the ingredients used as, for example, the standard breeding mash will be referred to as mixture 1234, mixture No. 2 as 1207, etc.

Using average prices of the different ingredients in 1930-1931, the prices of these different mash mixtures were as follows:

Mash mixture No. 1 (1234).....	₱7.28 per 100 kgm.
Mash mixture No. 2 (1207).....	6.68 per 100 kgm.
Mash mixture No. 3 (1504).....	6.83 per 100 kgm.
Mash mixture No. 4 (2206).....	8.26 per 100 kgm.
Mash mixture No. 5 (2026).....	8.56 per 100 kgm.
Mash mixture No. 6 (2008).....	8.16 per 100 kgm.
Mash mixture No. 7 (2800).....	8.56 per 100 kgm.

The grain mixture given to all pens cost an average of ₱6.90 every 100 kilograms. This average price represents the average of the prices of the different grain mixtures used during the different months of the experimental year.

Records. Trapnest records of all the birds were kept. The amount of feeds consumed was also carefully recorded. The birds in the different lots were weighed at the beginning of the experiment and these weights were compared with the weights taken at the close. Mortality records were also kept.

TABLE 2

Showing the percentage production of the different pens fed with the different mash mixtures studied

MONTHS	MASH MIXTURES FED						
	1-2-3-4	1-2-0-7	1-5-0-4	2-2-0-6	2-0-2-6	2-0-0-8	2-8-0-0
September.....	24.4	25.9	24.1	28.9	27.2	29.6	30.5
October.....	31.7	22.2	21.0	26.2	25.2	27.9	23.5
November.....	30.7	22.1	18.6	26.1	29.7	28.8	21.9
December.....	35.0	32.9	24.4	31.5	31.6	29.9	28.0
January.....	33.3	28.9	29.9	39.2	33.3	34.8	31.2
February.....	38.5	33.2	30.7	36.1	38.6	33.4	34.4
March.....	38.6	36.2	34.4	40.8	39.2	34.4	36.1
April.....	37.2	25.3	29.3	33.6	34.9	31.0	29.9
May.....	35.5	27.5	27.3	34.7	34.3	29.6	28.1
June.....	33.6	25.6	27.0	31.6	35.2	29.0	28.7
July.....	34.9	24.3	24.5	30.8	31.9	27.2	25.4
August.....	32.8	27.6	25.1	38.8	33.8	28.5	27.0
Average.....	33.79	27.61	26.29	33.42	32.88	30.18	28.72

RESULTS AND DISCUSSION

Egg production

The effects of the different mash mixtures studied on the number of eggs produced are given in table 2 and represented graphically in chart

For clearer discussion, the results are presented in three series as follows:

1. Where the amount of the copra meal in the standard breeding mash mixture has been replaced weight for weight by either corn meal or rice bran. (Mixtures 1207 and 1504).

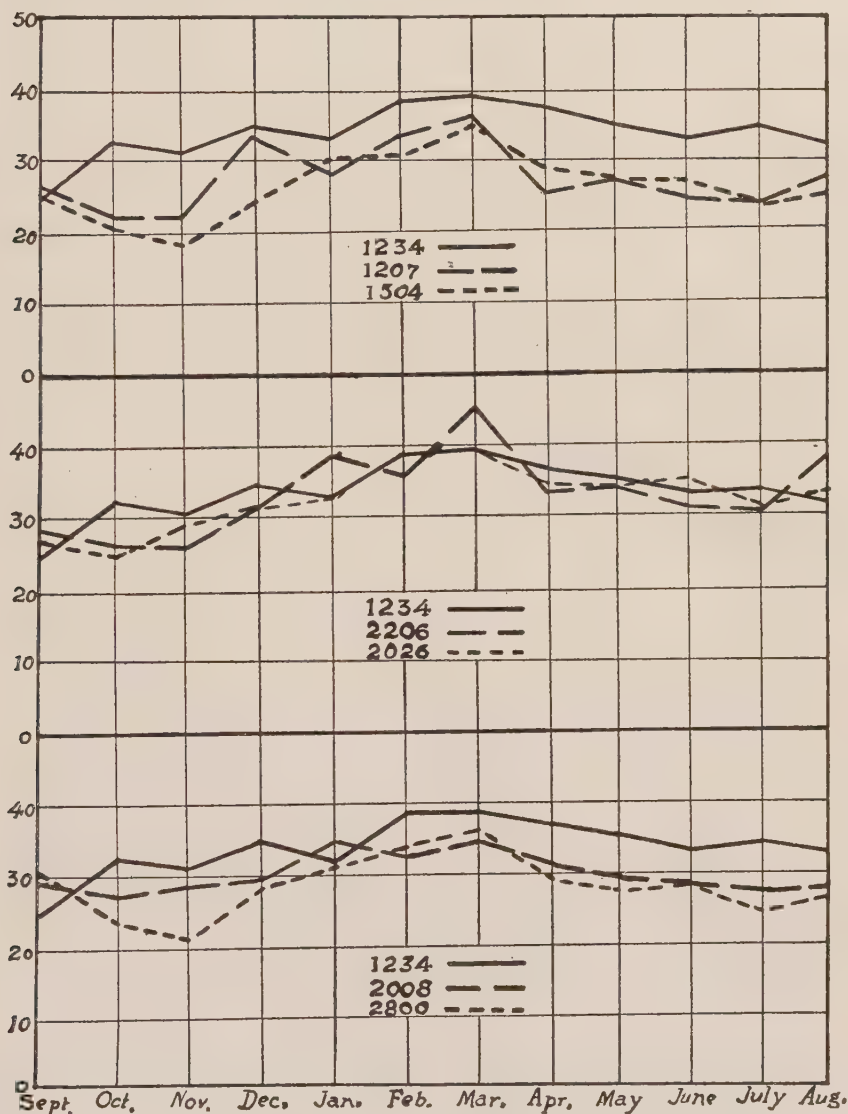


Chart 1.—The effects on egg production of the various mash mixtures studied. The solid lines represent the egg production of the lot given the standard breeding mash mixture, 1234, and the other lines represent the production with the test mashes.

2. Where the mash mixture is composed of a new combination of only three ingredients. (Mixtures 2206 and 2026).

3. Where the mash mixture is the simplest that can be used under general Philippine farm conditions. (Mixtures 2008 and 2800).

Mash mixtures 1207 and 1504. By reference to table 2 and chart 1, it may be seen that mash mixtures 1207 and 1504 had practically the same effect upon egg production, if any difference, mash mixture 1207 had a little advantage over mash mixture 1504, although probably not significant. The pen that received the 1207 mixture laid 2403 eggs and the one that was given the 1504 mixture produced 2240 eggs, or a difference of 163 eggs in favor of mixture 1207. However, if the average egg production is taken into consideration, the 1504 pen laid 27.61 per cent and the 1207 pen, 26.29 per cent. Expressed in terms of eggs per bird, the birds that were fed the mixture 1207 averaged 100.8 eggs each, while those that were given mixture 1504 averaged 96.0 eggs each. When compared with the standard breeding mash, mixture 1234, it will be seen that the average egg production of the birds that received these mashes was much lower than those that received the standard mash, the difference in the total number of eggs laid being 609 and 772 in favor of the standard breeding mash, mixture 1234. Expressed in average egg production, the differences are 6.18 per cent or 22.5 eggs and 7.50 per cent or 27.4 eggs, in favor of the lot that received the standard breeding mash. By reference to chart 1, it may be seen that at no period during the year was the egg production of the lot that received the standard mixture exceeded by either of the lots that received the test mixtures.

Mash mixtures 2206 and 2026. From the standpoint of egg production, mash mixtures 2206 and 2026 compared favorably with the standard breeding mash, mixture 1234. No significant differences either in the total number of eggs produced or in the average production of each bird were observed in the different lots. The standard mash mixture lot produced a total of 3012 eggs; the lot that received mixture 2206 produced a total of 3050 eggs; and the lot that was fed mixture 2026 laid a total of 3000 eggs. Expressed in average egg production, this would be 33.79 per cent or 123.3 eggs for mixture 1234, 33.42 per cent or 122.0 eggs for mixture 2206 and 32.88 per cent or 120.0 eggs for mixture 2026. The curves of egg production of these three lots crossed at various periods during the year. (See table 2, chart 1).

Mash mixtures 2008 and 2800. The total number of eggs produced is 2689 by the lot that received mixture 2008 and 2595 eggs by the lot that was fed mixture 2800. Expressed in average egg production the results would be 30.18 per cent or 110.2 eggs in the lot that received the mixture 2008 and 28.72 per cent or 104.8 eggs in the lot that received the mixture 2800. While the mash mixture 2008 had a shade of an advantage over the mixture 2800, and while both of these had a little advantage over either mixture

1207 or 1504, neither can compare favorably with the standard breeding mash, mixture 1234, and neither with either of the new compositions, mixtures 2206 and 2026. The curves of egg production of the three lots under consideration show that except in the beginning, September, and in January in the case of the lot that received the 2008 mixture, the curve of egg production of the lot that received the standard breeding mash mixture was all the time higher than the other two. (See table 2, chart 1).

One very important point brought out by these results is that where corn meal has been replaced with fine rice bran, weight for weight, the effect of the mash mixture on egg production is slightly better than where corn meal has been used. Considering that rice bran is much more easily available in most parts of the Islands than corn meal, fine rice bran should be more liberally used than at present as the basic component of mash feeds for egg production. The difficulty of the preparation of corn meal is another argument that may be mentioned in favor of the popular rice by-product, rice bran.

TABLE 3

Showing the amount and value of the feeds consumed by the different pens fed with the different mash mixtures studied

MASH FED	GRAIN ^a	VALUE	MASH	VALUE	TOTAL	VALUE
	<i>kgm.</i>	<i>pesos</i>	<i>kgm.</i>	<i>pesos</i>	<i>kgm.</i>	<i>pesos</i>
1-2-3-4	327.5	22.60	330.8	24.08	658.3	46.68
1-2-0-7	356.5	24.60	356.1	23.79	702.6	48.39
1-5-0-4	356.8	24.62	356.3	24.33	713.1	48.95
2-2-0-6	359.9	24.83	358.6	29.25	718.5	54.08
2-0-2-6	357.9	24.69	356.7	30.53	714.6	55.22
2-0-0-8	354.0	24.43	352.0	28.72	706.0	53.15
2-8-0-0	360.0	24.84	360.0	30.82	720.0	55.66

^aThe value of the grains was 6.91 centavos a kilogram, computed using the average cost per kilogram according to the following mixtures used:

From September to December.....2 corn + 1 palay

From January to February.....Palay only

From March to August.....1 corn + 1 palay

Amount and value of feeds consumed

Amount of feeds consumed. By reference to table 3, it may be seen that, with the exception of the lot that received the standard mixture, the amounts of feeds consumed by the lots that were given the mash mixtures that were studied were practically the same. The birds in the lot that

received the standard breeding mash, mixture 1234, consumed an average of only 26.33 kgm. of feed each, while those in the lot with mixture 1207 consumed 28.10 kgm.; with mixture 1504, 28.52 kgm; with mixture 2206, 28.74 kgm.; with mixture 2026, 28.28 kgm; with mixture 2008, 28.24 kgm.: and with mixture 2800, 28.80 kgm. These results may mean that the standard mash mixture is less palatable than the mash mixtures that were tested. The amount of the copra meal in the ration probably does make the standard breeding mixture less palatable than the test mixtures.

Returns from the sale of eggs above the cost of feeds. By reference to table 4, the total income derived from the sale of eggs as well as the total cost of feeds consumed by the different pens given the different mash mixtures may be seen. The largest incomes were derived from the sale of the eggs produced by the lots that received the standard breeding mash, mixture 1234, and the lots that were given mixtures 2206 and 2026, the difference between these three lots being insignificant. The lot that received the 1504 mixture brought in the smallest income, ₱89.60. When the total cost of feeds consumed by the different lots was deducted from the income derived from the sale of eggs, the returns received from the sale of eggs above the cost of feeds varied from ₱40.65 to ₱73.80, the lot that received the 1504 mixture being the lowest and the lot that was given the standard breeding mash, the highest. The lot that was fed the 2206 mixture ranked second with ₱67.12, and the lot that received the 2026 mixture ranked third with ₱64.78. While the amount of feeds consumed by the different pens that received the test mixtures was practically the same, the value of the different mixtures varied considerably. This explains why the total costs of the feeds in the different lots were not as uniform as the amount of the feeds consumed.

Cost of egg production. By reference to table 4, the cost of feeds needed to produce one dozen eggs may also be seen. This was obtained by dividing the total cost of feeds consumed by the total number of eggs produced by the lot and multiplying the quotient by 12. It may be seen that the lot that received the standard breeding mash, mixture 1234, produced the most economical eggs, 18.6 centavos a dozen. If the cost of feeds represents 60.3 per cent of the total cost of production (Fronza and Paje, 1930), to produce one dozen eggs required a total of 30.8 centavos. The most expensive eggs were produced at a cost of 26.2 centavos in feeds alone, or a total cost of 43.4 centavos for every dozen. The lots that were given the mixtures 1504 and 2800 produced these expensive eggs. The lots that were fed the mixtures 2206 and 2026 produced eggs at about the same cost per dozen, 35.3 centavos and 36.6 centavos, respectively. Both lots produced eggs at a higher cost than those produced by the lot that received the stand-

ard mash mixture which cost only 30.8 centavos a dozen. The eggs produced by the lots that received mixtures 1207 and 2008 cost about the same and ranked third.

TABLE 4

Showing the returns from the eggs over the value of feeds consumed, the cost of feeds to produce one dozen eggs and the total cost of production of each dozen eggs produced

MASH FED	VALUE OF EGGS PRODUCED ^a	COST OF FEEDS CONSUMED	RETURNS ABOVE COST OF FEEDS	COST OF FEEDS TO PRODUCE ONE DOZEN EGGS	TOTAL COST OF PRODUCING ONE DOZEN EGGS
	pesos	pesos	pesos	centavos	centavos
1-2-3-4	120.48	46.68	73.80	18.6	30.8
1-2-0-7	96.12	48.39	47.73	24.0	39.8
1-5-0-4	89.60	48.95	40.65	26.2	43.4
2-2-0-6	121.20	54.08	67.12	21.2	35.2
2-0-2-6	120.00	55.22	64.78	22.1	36.6
2-0-0-8	107.56	53.15	54.41	23.8	39.5
2-8-0-0	103.68	55.66	48.02	26.2	43.4

^aTo find the total number of eggs produced, divide the total value by ₱0.04, the price at which the eggs were sold.

Efficiency of the mash mixtures studied. Table 5 shows a comparison of the relative efficiencies of the different mash mixtures studied, expressed in percentage. Considering the results obtained from the lot that received the standard mash mixture as 100 per cent, it may be seen that mash mixture 2206 ranked second, this being 98.9 per cent in egg production, 90.9 per cent when the comparison was based on the amount of returns from the sale of eggs above the cost of feeds consumed and 86.0 per cent if based upon the cost of feeds needed to produce one dozen eggs. The lot given this mash mixture, 2206, produced results that were closest to those produced by the lot that received the standard breeding mash. On the other hand, the lot that received mixture 1504 produced the poorest results, being only 77.8 per cent as efficient as the standard mash in egg production, 55.1 per cent in returns from the sale of eggs above the cost of feeds consumed and 59.1 per cent as efficient as the standard breeding mash if the cost of feeds needed to produce one dozen eggs is considered. In this last item, mixture 2800 tied with mixture 1504 for being the least efficient of all the mash mixtures compared. The ranking of the other mash mixtures studied may be seen in table 5.

TABLE 5
Showing a comparison of the relative efficiencies of the different mash mixtures studied

MASH FED	AVERAGE NUMBER OF EGGS	RELATIVE EFFI- CIENCY	RETURNS ABOVE COST OF FEEDS	RELATIVE EFFI- CIENCY	COST OF FEEDS TO PRODUCE ONE DOZEN EGGS	RELATIVE EFFI- CIENCY
		<i>per cent</i>	<i>pesos</i>	<i>per cent</i>	<i>centavos</i>	<i>per cent</i>
1-2-3-4	123.3	100.0	73.80	100.0	18.6	100.0
1-2-0-7	100.8	81.7	47.73	64.7	24.0	71.0
1-5-0-4	96.0	77.8	40.65	55.1	26.2	59.1
2-2-0-6	122.0	98.9	67.12	90.9	21.2	86.0
2-0-2-6	120.0	98.1	64.78	87.8	22.1	81.2
2-0-0-8	110.2	89.3	54.41	73.7	23.8	72.0
2-8-0-0	104.8	85.0	48.02	65.1	26.2	59.1

Effect of the mash mixtures on the birds. Generally speaking, the different mash mixtures studied did not produce any unfavorable influence on the birds. They were apparently in as good a condition at the end of the experiment as at the beginning. As may be seen from table 6, all lots gained in weight. This may be expected as the birds were young pullets at the beginning of the experiment and of course had not yet reached their maximum body weight. All the mash mixtures studied, with the possible exception of mixtures 1207 and 1504, have a little fattening effect upon the birds. While the birds that were given these two rations gained in weight also, the gains were not as much as those made by the birds in the other lots. Mash mixtures 1504 and 2800, contrary to expectation, were, after all, not conducive to fattening. Mash mixtures 2206 and 2026

TABLE 6
Showing the effect of the different mash mixtures on the weights of the birds

MASH FED	AVERAGE WEIGHTS		INCREASE IN WEIGHT	PER CENT
	Initial	Final		
	<i>grams</i>	<i>grams</i>	<i>grams</i>	
1-2-3-4	1,270	1,440	170	13.3
1-2-0-7	1,200	1,320	100	8.1
1-5-0-4	1,330	1,430	100	7.5
2-2-0-6	1,310	1,510	200	15.3
2-0-2-6	1,230	1,470	240	19.5
2-0-0-8	1,260	1,430	170	13.5
2-8-0-0	1,330	1,480	150	11.3

were expected to have least effect on fattening the birds, but as the results show, those fed with these mixtures made the largest gains in weight.

From the point of view of mortality of the birds, mash mixtures 2206 and 2026 probably had a slight advantage over the other mixtures, as there was no mortality recorded from these pens. Of the pen that was given mixture 1207, two out of twenty-five or 8.0 per cent died. This lot had the highest mortality during the year. However, this mortality record is well within the normal range. If the increases in weight of the birds, together with the absence of mortality, are taken as criteria, mixtures 2206 and 2026 may be considered as the best of all the mash mixtures studied, although this advantage is probably only slightly significant, if there is any advantage at all.

SUMMARY AND CONCLUSIONS

1. If copra meal cannot be obtained at reasonable prices, mixture 2206 may be used. This ranks second to the standard breeding mash, mixture 1234, in value.
2. A mash mixture composed of 2 parts dried shrimps and 8 parts fine rice bran produced fairly profitable results.
3. Where copra meal is cheap, but facilities for grinding corn are not available, a mash mixture composed of 2 parts dried shrimps, 2 parts copra meal and 6 parts fine rice bran may be used.
4. Basing conclusions on the cost of feeds needed to produce one dozen eggs, mash mixtures 1504 and 2800 were observed to be the least efficient.
5. Mash mixture 1504 was observed to be the least efficient of all the mash mixtures tested.
6. One very important point brought out by these results is that where corn meal has been replaced with fine rice bran, weight for weight, the effect of the mash mixture on egg production is slightly better than where corn meal has been used.

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THE NUTRITIVE VALUE OF "GALLAN", *CYRTOSPERMA* *MERKUSII* (HASSK.) SCHOTT¹

ARTEMIO E. GESMUNDO

Gallan (Tag.), *Cyrtosperma merkusii* (Hassk.) Schott is a tuberous wild food plant belonging to the family Araceae. It is also known as *palauan* or *biha* in the Visayan islands and as *galiang* in the Bicol provinces. It is a huge herbaceous aroid with broad shiny green leaves provided with long cylindrical petioles, the lower part of which are spiny. These petioles gradually taper towards the tip. It is a rather tall plant ranging from one to five meters, depending upon the nature of the soil and place in which it is grown (Quisumbing, 1914). The young purplish inflorescence, spadix, is tubular, covered with a bract, gradually tapering towards the tip and not unlike an ear of corn in shape and form. Externally, the tuber resembles a banana sucker.

Gallan is grown to a limited extent in the Visayan islands and in southern Luzon (Wester, 1924). It is usually grown in swampy places and in soils that are constantly moist and useless for producing important agricultural crops. In Luzon, particularly in Pila, Laguna, where most of the materials used in this work were obtained, it is grown in localities that are low, as places around the vicinity of the rice paddies. In San Pablo, Laguna, it is found growing between large stones on steep hills where there is a constant flow of water. In this particular place, the tubers are used by the owner primarily as irrigation dikes, or levees. It is also grown in Camarines. Some gallan is grown in Capiz, Leyte, and in Samar and possibly the plant may be found growing in other places in the Islands where its usefulness may not be known.

Gallan can be grown easily as it needs no special care. When planted, gallan like gabi, ubi, and ginger is cut at the base of the shoot leaving about two centimeters of the tuber. The side shoots are cut in a similar manner. Both the cut main tuber and side tubers are planted about a meter apart by sticking them in swampy ground or in places that are constantly moist. The plant requires practically no cultivation.

Gallan has a long period to maturity. A tuber of fairly good size may be obtained at the age of four years from the date of planting. It is claimed that below this age, gallan tuber is not pleasing to the taste. It

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is also claimed that the best time to harvest gallan is at the age of five or six years when its tuber is said to be at its maximum usefulness, because beyond this age it becomes too old and new plants begin to develop from it. The yield per hectare is not known inasmuch as no information in this regard could be obtained from those who grow gallan.

Gallan tuber is used for food. In Pila and in San Pablo, both in Laguna Province, a number of food preparations are made from gallan. Among these are, jam, *bibinka* (hot cake) *minokmok* (powdered boiled gallan, mixed with grated coconut and sugar), *suman* (finely grated gallan mixed with sugar and grated coconut or coconut milk—wrapped with banana leaves and boiled), *palitao* or *bilobilo* (boiled dumpling), and *maduya* (fritter). It is sometimes used in place of sweet potato tubers in a Spanish viand called *puchero*. It was learned from a native of Camarines that when there was scarcity of rice in 1920 in that region, gallan tuber served as a good substitute food. It was said that a number of people managed to live for some time on this tuber alone. After the typhoon of November 5, 1928, which did much damage in Samar, the people of that island subsisted for a time on gallan tuber. The people of Leyte, to a certain extent, also made use of this tuber at that time. Young leaves and young inflorescence of gallan are used by the Visayans and by some Tagalogs as a vegetable in cooking. In Capiz, in Leyte and in Samar it is said that their use as *gulay* is very well known.

Despite these facts, however, it is to be regretted that this useful tuber is still unknown to a large number of Filipinos. In many places, it is even regarded as poisonous. No report of its food value could be found in available literature. It was to find out the food value of this plant that the experiments here reported were conducted.

The experiments were conducted in the Biochemical Laboratory of the College of Agriculture, University of the Philippines, for a period of ten months from May 16, 1929 to February 15, 1930.

MATERIALS

The animals

Rats. Young, healthy, albino rats of both sexes were used. Each albino rat was confined in a wire cage which was cleaned regularly. Coarse paper was placed on the bottom of the cage below a wire screen to serve as urine absorbent. The rats were fed and given water daily. The body weight and the food intake were determined by weighing twice a week, on Tuesdays and Saturdays. The urine absorbents were changed at least once a week.

Chickens. Cockerels, approximately three to four months old, were confined in chicken cages. Like the albino rats, they were fed and given water every day. The body weight and food intake were determined by weighing on Tuesdays and Saturdays. The cages were cleaned often.

Rabbits. Middle-aged rabbits of both sexes were used. They were given grass, gallan meal and water daily. The cages were cleaned every day. Their body weights and gallan meal intake were determined by weighing on Tuesdays and Saturdays.

Guinea pigs. Middle-aged guinea pigs of both sexes were confined in one cage. Like the rabbits they were fed and given water daily. Their body weights and gallan intake were determined by weighing on Tuesdays and Saturdays.

The feeds

Basal diets. (1) For albino rats: The basal diet in the determination of the water soluble growth promoting vitamin consisted of the following:

Starch.....	64 grams
Casein.....	18 grams
Butter fat.....	9 grams
Vegetable fat.....	3 grams

McCollum and Davis' (1915)

Salt mixture.....	4 grams
Paper.....	2 grams

Corn starch, Liberty brand, was used. The casein (Merk's) before using was washed nine times with water, pressed between the palms and dried in the sun. The butter fat was obtained from Golden State butter. It was heated in a water bath until the fat melted, and with the aid of a separatory funnel the salty portion was removed and separated from the butter fat. The butter fat was washed with hot water to remove any traces of salt that might have remained with the fat. Vegetable fat, Marifosa brand, was used. Mimeograph bond paper was soaked in water until it became soft. It was then macerated and dried thoroughly in the sun.

(2) Chickens: The basal diet in the determinations of the anti-neuritic vitamin of gallan tuber had the following composition:

Washed polished rice.....	85 grams
Washed casein (Merks).....	10 grams
Salt mixture.....	5 grams

Polished rice was washed until several washing waters were clear. It was then allowed to dry in the open air. The casein and salt mixture used were the same as those given in the basal diet for the albino rats. Gravel and charcoal were given every once in a while.

(3) Rabbits and guinea pigs: Grass was used with these animals.

Materials to be tested. The materials tested were the following:

- (1) Gallan tuber
- (2) Young leaves of gallan
- (3) Young inflorescence of gallan

The materials used were obtained from Pila and San Pablo, Laguna. In the early part of the work gallan tuber was also secured from Malinao, Capiz, through the courtesy of the Municipal President. The tubers were about four years old.

The fresh tuber of gallan was peeled, cut into fair-sized pieces, washed once with tap water, then boiled. After cooking, the pieces were thinly sliced and dried in the sun. On rainy days drying was accomplished in the oven of the cooking stove in Molawin Hall in the early part of the work before the Biochemical Laboratory electric oven was installed. When thoroughly dried, the thin slices of gallan tuber were ground in a palay grinder. When it was intended for the feeding of chickens, rabbits and guinea pigs, the cooked dried tuber was ground coarse. It was ground finer for the feed of the albino rats.

The young leaves used, including the midribs and the soft portions of the petioles, were cut into pieces and then dried in the open air. The young inflorescence was cut in a similar manner and dried the same way.

Proximate chemical analysis: Fresh samples of gallan tuber obtained from the three sources and young leaves and inflorescence were submitted to the Agricultural Chemistry Experiment Station for proximate analysis (table 1).

THE METHODS

Test with the albino rats. (1) For the determination of the efficiency of the tuber as a source of water soluble growth promoting factor albino rats were employed. They were given the basal diet supposedly complete in all the food essentials except the vitamin in question. As soon as they had lost considerable weight, they were given the gallan tuber meal in addition to the basal diet.

(2) Also for the determination of the efficiency of gallan tuber meal as source of carbohydrates and water soluble growth promoting factor albino rats were used. They were given the following ration daily:

Gallan tuber (meal).....	340 grams
Casein.....	52 grams
Vegetable fat.....	46 grams
Salt mixture.....	14 grams
Filter paper.....	6 grams

(3) For the determination of the efficiency of young leaves as source of water soluble growth promoting substance, albino rats were again used. They were given the basal diet daily and as soon as they showed marked decrease in weight, they were given dried young leaves in addition to the basal diet.

(4) For the determination of the efficiency of young inflorescence as source of the growth promoting water soluble factor, albino rats were used. The rats were treated as in (3).

Test with chickens. In this set only the gallan tuber was tried because of the meager supply of the young leaves and the young inflorescence.

The chickens were daily given water and the basal diet, supposedly lacking only in the anti-neuritic vitamin. There were chickens that increased in weight for a few days on this diet, and there were some that very soon decreased in weight. When the chickens' weights were markedly low and when they were weak and could not stand, had lost their appetite and had stiff necks bent like an arch, and had pale combs, they were given the supplementary diet daily. Because they were weak, and because they had lost their appetite, the chickens were hand-fed with the gallan tuber meal in the form of a wet mash. This was continued until they were able to take in food of their own accord.

Later, in the course of the experiment some of the chickens were turned on a diet in which coarse meal of gallan tuber was the sole source of carbohydrates and the anti-neuritic vitamin.

Test with rabbits and guinea pigs. Gallan tuber was again the only material tried with these animals. The only addition to the grass that was given them was gallan meal. The gallan meal was used as a concentrate. The amount of gallan meal eaten by the rabbits was separately determined. The guinea pigs were kept together in a cage so that separate actual determinations of the total gallan meal eaten by each was impossible. Prior to all these determinations both the rabbits and the guinea pigs were given raw gallan tuber in order to determine beforehand whether or not they liked it, also to make them somewhat used to it.

RESULTS AND DISCUSSION

Protocols of body weights and food intake are given in tables 2 to 14.

Efficiency of gallan tuber as source of water soluble growth promoting vitamin

In this determination two sets of four albino rats each were used. Each rat in the first set was given one gram and those in the second set were given two grams of the supplement daily in addition to the basal diet.

One gram supplement. All the four rats uniformly showed a decrease in body weight on the basal diet alone, but with the introduction of the supplement a marked change was noticed (table 2). There was a general tendency towards an increase in weight in each of the four albino rats. At certain points a slight decrease in weight was recorded but these losses were later on recovered.

On February 15, 1930 rats 2♀, 3♀ and 15♀ gave an increase of 60, 29 and 48 grams, respectively. Rat 1♂ was the only exception, because after a "drop" on November 2, 1929 it died on November 5, 1929. This death might be accounted for in part by the moldy supplement, for the rancidity of the basal diet, as a large amount of this had been prepared at the beginning, and in part to a sudden change of environmental condition. It was rainy, the days were windy beginning at about the close of October.

This disagreeable weather might have helped to cause the "drop" in weights of the rats that was noted about the end of the first week of November.

It may be noted further that rat 2♀ gave the highest gain, with rat 15♀ its close second, and rat 3♀ the least.

Two grams supplement. As in set 1 all the four rats exhibited almost the same growth curves (table 3). They decreased in body weight when fed with the basal diet alone; but when given the supplement they increased.

In all cases, the rats increased in body weight until finally by February 15, 1930 rats 4♀, 5♂, 8♀ and 16♂ had gained 91, 96, 59 and 51 grams, respectively.

Efficiency of young leaves of gallan as source of water soluble growth promoting vitamin

In this determination two sets, one of three and one of four, albino rats were used. Each of the rats in one set was given daily, one-half gram and each in the other set one gram of the young dried leaves as supplement.

One-half gram supplement (table 4). In all cases, the three rats increased in weight until by February 15, 1930 rats 9♂, 10♂ and 17♀ had gained 120, 62 and 79 grams, respectively. It may be noted that rat 10♂ made the least gain. This might be attributed to its condition at the beginning. Its initial weight was 94 grams. Although started on the same weight as rat 9♂, the gain of rat 17♀ in body weight was not as great as rat 9♂.

One gram supplement (table 5). In all cases, the four rats increased in body weight on one gram supplement. Rats 12♂, 13♀, 14♀ and 18♂ gained 119, 42, 68, and 142 grams, respectively. Here it may be noted that rat 13♀ gave the least increase, with rat 14♀ its close second. This little increase may be attributed to the fact that both these rats were more mature than the other two.

Efficiency of the young inflorescence of gallan as source of growth-promoting water soluble vitamin

In this determination ten albino rats were used. They were divided into two sets. The first set was given one-half gram and the second set one gram dried young inflorescence every day in addition to the basal diet. The body weight and the food intake of each of the rats are shown in tables 6 and 7.

One-half gram supplement. Six rats were employed here. Rats 6♂ and 7♀ died on July 21, 1929, a day after they were given the supplement. The supplement given them was not eaten. Rat 11♂ died on July 29, 1929. The cause of death could not be determined.

Rats 19♂, 21♀, and 22♂ made each a gain of 97, 86, and 109 grams, respectively, showing that one-half gram of the dried young inflorescence of gallan administered daily was enough to promote the growth of the albino rats.

One gram supplement. Three albino rats (rats 23♂, 24♀, 25♀) were employed in this set. The feeding was begun on September 10, 1929.

In this set, the increase in the body weights of all the rats was very apparent. Rats 23♂, 24♀, and 25♂ gained 110, 90, and 98 grams, respectively.

Efficiency of gallan tuber as source of carbohydrates and water soluble growth-promoting vitamin

In this determination four albino rats were used. The experiment was begun by Dr. F. O. Santos and Mr. E. G. Collado of the Department of Agricultural Chemistry on May 16, 1929 and was continued to July 13, 1929. Then, the work was turned over to the writer. The rats were fed with gallan meal ration.

In this set all the rats grew well. They were vigorous. Its sex and a physical injury it received might account for the little increase in rat 3♀ (table 8).

Efficiency of gallan tuber as source of carbohydrate and anti-neuritic vitamin

In this determination eleven chickens were used, six natives and five Cantonese (tables 9 to 12).

Test on the anti-neuritic vitamin content. In this test, the chickens were given the basal ration of 85 grams polished rice, 10 grams washed casein and 5 grams salt mixture.

On ten grams gallan meal as daily supplement to an otherwise sufficient diet, chicken No. 1 improved in weight; No. 2 also improved in weight but later died from unknown cause; No. 3 showed no improvement; No. 4 died of polyneuritis; Nos. 5 and 6 both improved; No. 12 showed very little improvement.

On fifteen grams gallan meal as daily supplement, No. 10 improved; but later on decreased in weight; No. 11 thrived for two months and then died; No. 9 died soon after gallan was given. All the three animals were unable to take all of the 15 grams daily supplement.

Test for the efficiency of gallan tuber as source of carbohydrate. On October 19, 1929 chickens Nos. 1, 3, 5 and 6 (tables 9 and 10) were given a diet in which gallan meal, coarsely prepared, replaced the rice of the basal diet. The initial weights considered here were those of the October 19, 1929 weighings. Nos. 1, 3, and 5 continued increasing in weight, but No. 6 did not and later on it died.

Efficiency of gallan tuber as a concentrate

In this determination four rabbits and three guinea pigs were used. They were given grass as roughage and gallan meal, coarsely prepared, as the concentrate.

Test with rabbits. All of the three rabbits followed a general ascending weight curve. The total gain of rabbit 1♀, from August 31, 1929 to February 15, 1930 was 1264 grams; rabbit 4♂ from October 5, 1929 to Feb-

ruary 15, 1930 was 1590 grams, and rabbit 3♀, from August 31, 1929 to February 15, 1930, was 1216 grams.

Test with guinea pigs. The three guinea pigs increased in weight gradually. No. 2 gave birth to two young and No. 3 to one. All the young were successfully weaned and grew to maturity on the same diet.

SUMMARY AND CONCLUSIONS

1. One gram air-dried and powdered gallan tuber when given as supplement to a diet that is supposedly complete except for the water soluble growth-promoting vitamin enabled albino rats which were decreasing in weight to recover and to grow.

2. One-half gram of air-dried young leaves of gallan when given as supplement to a diet that is supposedly complete except for the water soluble growth-promoting vitamin enabled albino rats which were decreasing in weight to recover and to grow.

3. One-half gram of air-dried young inflorescence of gallan when given as supplement to a diet that is supposedly complete except for the water soluble growth-promoting vitamin enabled albino rats which were decreasing in weight to recover and to grow.

4. When gallan tuber was used as the only source of carbohydrates, it enabled albino rats to grow. This seems to indicate that gallan tuber is a good source of carbohydrate and as such furnishes enough water soluble growth-promoting vitamin for the need of albino rats.

5. Indications have been obtained that, for chickens, gallan tuber is not rich in anti-neuritic vitamin.

6. As the only source of carbohydrates for chickens, gallan tuber appears to be fair. As such it seems to furnish sufficient amount of anti-neuritic vitamin for chickens.

7. As concentrate for rabbits and guinea pigs gallan tuber was found to be good.

TABLE 1

Showing the chemical composition of gallan tuber, young inflorescence and young leaves on the basis of fresh samples

SAMPLES	PLACE OF ORIGIN	MOISTURE	FAT	ASH	PRO-TEINS	CRUDE FIBER	NITROGEN FREE EXTRACT	CALORIES PER 100 GRAMS
		<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	
Tuber.....	Capiz.....	61.48	0.32	1.35	0.91	1.36	34.58	150
Tuber.....	San Pablo.	59.82	0.47	1.60	1.38	1.26	35.47	155
Tuber.....	Pila.....	69.32	0.42	1.22	0.72	1.43	26.89	120
Young inflorescence..	Pila.....	89.36	0.65	1.57	2.38	1.38	4.66	35
Young leaves ^a	Pila.....	86.32	0.65	2.02	5.04	1.54	4.43	45
Midribs and soft portions of petioles...	Pila.....	91.86	0.32	1.29	2.15	1.27	3.11	25

^aMidribs and soft portions of petioles excluded.

TABLE 2

Showing weekly body weight and food intake of rats with one gram gallan tuber as supplement

DATE	RAT 1♂		RAT 2♀		RAT 3♀		RAT 15♀	
	Body weight	Food intake	Body weight	Food intake	Body weight	Food intake	Body weight	Food intake
	grams	grams	grams	grams	grams	grams	grams	grams
1929								
June 30	137		99		106		110	
July 7	134	77	79	43	98	9	107	50
14	116	48	64	27	79	25	93	69
21	106	15	53	18	76	23	85	12
27	89 ^a	22	54 ^a	25	71 ^a	24	82 ^a	24
August 3	91	23	61	30	74	36	83	35
10	96	38	69	32	89	37	92	32
17	101	58	74	45	93	41	99	38
24	115	41	87	37	100	41	109	37
31	120	46	105	43	108	52	106	46
September 7	124	50	99	33	114	43	119	43
14	126	40	103	38	117	35	123	47
21	122	33	106	40	120	39	125	41
28	124	41	110	39	121	33	124	38
October 5	125	35	111	27	119	23	124	33
15	119	48	111	50	119	35	125	62
19	117	16	111	14	119	16	127	24
26	114	38	111	42	114	30	124	49
November 2	97	24	104	20	106	24	109	20
9			97 ^b	27	96 ^b	20	99 ^b	21
16			118	50	115	51	117	52
23			135	62	122	39	129	57
29			140	39	124	38	139	24
December 7			144	53	135	41	141	58
14		Died	152	53	132	56	139	63
21			150	42	132	30	147	45
28		on	150	46	130	40	150	54
1930								
January 4	November 5/29		152	55	130	40	155	56
11			157	57	133	50	150	53
18			161	49	137	44	152	45
25			161	52	140	44	155	52
February 1			161	41	140	18	160	56
7			159	34	135	40	155	46
15			159	36	135	45	158	60

^a One gram supplement was administered.

^b Old prepared ration and supplement changed for that freshly prepared.

TABLE 3

Showing weekly body weight and food intake of rats with 2 grams gallan tuber as supplement

DATE		RAT 4♀		RAT 5♂		RAT 8♀		RAT 16♂	
		Body weight	Food intake	Body weight	Food intake	Body weight	Food intake	Body weight	Food intake
1929		grams	grams	grams	grams	grams	grams	grams	grams
June	30	73		62		88		139	
July	7	78	69	58	51	91	49	136	62
	14	62	30	53	30	74	18	111	23
	21	60	14	52	33	71	34	104	38
	27	57 ^a	13	46 ^a	20	63 ^a	23	98 ^a	19
August	3	57	34	59	42	76	54	96	45
	10	71	33	72	33	85	42	109	40
	17	84	41	82	37	98	55	126	46
	24	99	37	100	44	106	29	143	52
	31	106	49	108	53	104	58	151	53
September	7	112	42	114	41	115	40	158	49
	14	125	46	114	33	122	38	160	48
	21	131	46	122	63	123	28	163	47
	28	134	40	118	37	123	30	164	45
October	5	136	33	117	39	121	27	165	39
	15	134	48	112	56	122	51	162	69
	19	133	22	114	24	122	21	164	27
	26	130	32	111	45	119	33	158	38
November	2	118	21	103	22	112	23	139	27
	9	103 ^b	9	96 ^b	26	102 ^b	11	117 ^b	19
	16	115	33	99	27	111	24	151	72
	23	125	51	100	39	116	32	162	64
	29	134	25	110	38	127	31	176	52
December	7	144	54	120	54	133	36	179	49
	14	144	47	120	49	131	48	176	48
	21	150	33	128	36	141	27	181	35
	28	154	45	136	52	143	58	181	51
1930									
January	4	150	38	140	38	148	54	184	50
	11	156	46	144	51	150	50	184	50
	18	156	35	152	36	150	32	190	52
	25	159	41	156	49	150	43	190	48
February	1	164	48	160	29	150	34	190	40
	7	164	35	155	39	143	39	188	38
	15	164	51	158	41	147	63	190	60

^aTwo grams supplement were given.^bOld ration and supplement changed for that freshly prepared.

TABLE 4

Showing weekly body weight and food intake of rats with one-half gram dried young leaves of gallan tuber as supplement

DATE	RAT 9 ♂		RAT 10 ♂		RAT 17 ♀	
	Body weight	Food in- take	Body weight	Food in- take	Body weight	Food in- take
	grams	grams	grams	grams	grams	grams
<i>1929</i>						
June 30.....	79		94		79	
July 7.....	89	57	76	18	88	53
14.....	75	29	61	34	73	40
21.....	66	13	58	17	64	9
27.....	64 ^a	24	55 ^a	20	59 ^a	21
August 3.....	77	43	59	49	64	38
10.....	85	37	69	34	80	56
17.....	99	47	86	36	92	60
24.....	111	57	96	40	99	35
31.....	114	53	104	67	106	101
September 7.....	127	41	116	70	119	36
14.....	143	59	128	82	122	49
21.....	150	33	134	62	122	43
28.....	148	56	138	57	127	47
October 5.....	155	59	138	55	128	41
15.....	159	79	139	65	132	74
19.....	165	36	139	33	137	30
26.....	162	45	144	55	138	61
November 2.....	137	34	126	31	115	23
9.....	136 ^b	61	107 ^b	19	99 ^b	20
16.....	155	68	129	49	113	50
23.....	158	63	134	55	118	49
29.....	171	60	144	45	132	52
December 7.....	179	82	151	47	145	59
14.....	175	65	146	69	148	37
21.....	178	61	150	48	140	69
28.....	176	61	152	66	144	49
<i>1930</i>						
January 4.....	186	101	136	42	153	60
11.....	190	88	136	51	153	69
18.....	192	80	128	32	147	50
25.....	187	61	140	68	142	50
February 1.....	192	87	133	42	145	54
7.....	194	65	146	57	145	48
15.....	199	92	156	76	158	68

^aOne-half gram supplement was administered.

^bOld prepared ration changed for one freshly prepared.

TABLE 5

Showing weekly body weight and food intake of rats with one gram dried young leaves of gallan as supplement

DATE	RAT 12 ♂		RAT 13 ♀		RAT 14 ♀		RAT 12 ♂	
	Body weight	Food intake	Body weight	Food intake	Body weight	Food intake	Body weight	Food intake
	grams	grams	grams	grams	grams	grams	grams	grams
1929								
June 30	84		124		110		71	
July 7	78	41	115	49	109	35	71	50
14	64	29	100	30	102	30	61	26
21	64	18	91	10	84	8	59	30
27	61 ^a	10	85 ^a	5	76 ^a	1	54 ^a	16
August 3	71	55	101	52	89	48	56	39
10	84	50	115	58	105	60	71	34
17	100	57	121	60	118	48	83	55
24	120	55	135	53	135	54	100	42
31	130	72	137	52	140	63	116	67
September 7	141	59	142	60	146	60	137	67
14	148	55	145	53	152	49	138	51
21	160	63	146	47	158	37	142	49
28	160	52	151	60	156	64	144	68
October 5	164	60	149	64	156	54	150	59
15	166	75	154	94	164	88	158	91
19	171	41	158	36	167	32	166	41
26	177	84	152	67	165	64	168	76
November 2	150	37	129	24	142	28	143	29
9	144 ^b	60	108 ^b	19	118 ^b	19	119 ^b	23
16	151	73	132	63	143	54	146	62
22	158	68	139	57	154	65	151	64
29	175	74	149	48	160	54	167	60
December 7	188	65	160	69	173	76	175	75
14	180	80	155	73	168	68	177	74
21	187	71	162	65	174	54	177	48
28	189	64	162	59	178	62	177	55
1930								
January 4	195	80	155	57	175	60	184	75
11	202	92	152	41	175	63	195	77
18	202	62	159	68	178	64	200	73
25	196	62	159	51	178	63	204	61
February 1	200	65	159	60	183	66	207	71
7	198	58	159	3	178	47	207	66
15	203	92	166	26	178	58	213	89

^aSupplement started.

^bOld prepared ration and supplement changed for that freshly prepared.

TABLE 6

Showing weekly body weight and food intake of rats with one half dried young inflorescence of gallan as supplement

DATE					RAT 11 ♂	
	Body weight	Food intake	Body weight	Food intake	Body weight	Food intake
	grams	grams	grams	grams	grams	grams
1929						
June 30.....					86	
July 7.....					75	35
14.....					66	31
21.....					63	32
	RAT 19 ♂					
27.....	99				58	23
August 3.....	104	69				
			RAT 21 ♀		RAT 22 ♂	
3.....			84		88	41
10.....	105	47	88	56	84	60
17.....	104	39	86	58	79	59
24.....	94	14	76	29	74	38
31.....	79 ^a	42	65 ^a	53	60 ^a	41
September 7.....	101	56	94	56	89	54
14.....	120	56	111	59	104	62
21.....	139	68	131	58	120	52
28.....	146	47	149	56	134	59
October 5.....	157	51	141	58	140	61
15.....	163	81	149	95	157	79
19.....	169	34	157	45	161	35
26.....	170	65	167	54	163	65
November 2.....	152	37	139	36	153	37
9.....	145 ^b	41	128 ^b	40	160 ^b	56
16.....	169	59	147	67	169	48
23.....	173	52	152	56	177	64
29.....	181	65	162	55	177	53
December 7.....	175	59	168	79	187	65
14.....	180	68	164	82	187	71
21.....	180	61	164	59	192	62
28.....	184	60	164	59	192	54
1930						
January 4.....	186	64	166	66	192	73
11.....	189	67	168	69	192	69
18.....	193	64	163	55	196	74
25.....	185	55	158	53	194	55
February 1.....	181	66	163	64	199	64
7.....	191	66	163	54	194	64
15.....	196	91	170	74	197	78

^aOne-half gram supplement was administered.

^bOld prepared ration and supplement changed for that freshly prepared.

TABLE 7

Showing weekly body weight and food intake of rats with one gram dried young inflorescence of gallan as supplement

DATE	RAT 23♂ ^a		RAT 24♀		RAT 25♀	
	Body weight	Food intake	Body weight	Food intake	Body weight	Food intake
	grams	grams	grams	grams	grams	grams
<i>1929</i>						
September 10.....	57		48		72	
17.....	64	31	54	33	80	42
24.....	59	17	52	29	75	28
October 1.....	53	21	45	15	63	13
8.....	50	13	39	7	54	11
15.....	42 ^a	7	37 ^a	17	49 ^a	16
22.....	66	33	60	34	78	48
29.....	76	45	69	40	90	52
November 5.....	87	38	85	39	104	51
12.....	90	39	90	48	106	52
19.....	100	40	97	35	112	38
26.....	107	48	100	32	118	48
December 3.....	114	45	103	49	127	53
10.....	122	53	110	43	134	55
17.....	125	41	109	47	141	56
28.....	125	75	114	62	148	93
<i>1930</i>						
January 4.....	137	62	120	54	151	67
11.....	143	61	127	52	158	96
18.....	155	54	132	56	165	61
25.....	157	58	139	50	165	56
February 1.....	161	56	143	52	167	83
7.....	161	54	138	51	161	44
15.....	167	77	138	63	170	74

^aStarted with supplement.

TABLE 8

Showing weekly body weight and food intake of rats with gallan tuber as source of carbohydrate and water soluble growth-promoting vitamin

DATE	RAT I ♂		RAT II ♂		RAT III ♀		RAT IV ♂	
	Body weight	Food intake	Body weight	Food intake	Body weight	Food intake	Body weight	Food intake
	grams	grams	grams	grams	grams	grams	grams	grams
1929								
May 16.....	64		57		60		50	
24.....	70	24	65	21	66	18	60	15
31.....	92	73	83	77	72	70	80	65
June 7.....	105	90	96	72	75	44	77	62
14.....	123	45	115	51	102	66	97	35
21.....	130	77	133	82	111	55	102	57
28.....	152	43	142	42	125	69	116	67
July 5.....	160	89	147	92	128	71	120	74
12.....	171	108	156	81	130	37	132	74
20.....	189	100	177	95	134	78	145	80
27.....	203	100	199	87	137	80	154	74
August 3...	221	106	205	93	146	79	167	97
10...	223	89	219	113	146	75	174	88
17...	224	67	230	95	137	67	175	80
24...	233	76	241	78	153	58	191	69
31...	237	114	241	89	146	82	191	98
September 7	255	110	253	101	154	73	198	116
14	258	87	256	90	156	59	201	82
21	261	89	264	106	158	88	208	102
28	255	99	260	99	160	69	213	95
October 5...	252	84	260	99	164	79	214	118
15...	260	135	265	144	166	121	217	156
19...	261	43	269	60	168	140	221	59
26...	257	94	266	105	163	70	215	107
November 2	260	94	267	98	163	61	215	85
9	251	92	270	107	161	68	213	93
16	254	81	272	100	165	58	206	79
23	258	100	262	87	164	69	202	97
29	262	82	252	35	164	52	217	90
December 7	264	106	269	110	159	76	224	112
14	272	114	269	105	159	78	215	109
21	274	87	273	107	161	69	228	103
28	274	100	267	103	161	80	219	88
1930								
January 4...	276	90	272	101	170	70	226	79
11...	268	90	267	122	126 ^a	35	219	93
18...	250	75	272	116	105	3	219	61
25...	244	87	272	111	137	85	214	88
February 1...	236	82	272	99	130	56	204	76
7...	225	98	272	98	112	48	200	78
15...	225	100	274	106	139	111	206	94

^aPhysically injured on January 8, 1930.

TABLE 9

Showing weekly body weight and food intake of chickens with gellan tuber as source of anti-neuritic vitamin and carbohydrate

DATE	CHICKEN 1		CHICKEN 2		CHICKEN 3	
	Body weight	Food intake	Body weight	Food intake	Body weight	Food intake
	grams	grams	grams	grams	grams	grams
1929						
July 2.....	531		579		783	
6.....	493	40	542	81	729	40
13.....	471	50 ^a	507	82 ^a	639	64 ^a
20.....	481 ^b	121	541 ^b	114	701 ^b	116
27.....	557	129	548	151	758	120
August 3.....	552	47	626	247	747	57
10.....	486	43	596	159	718	67
17.....	567	90	667	236	781	173
24.....	516	38	644	136	776	201
31.....	405	71	639	179	683	72
September 7.....	467	47	803	222	772	104
14.....	489	219	856	346	807	112
21.....	543	196	936	390	743	50
28.....	533	115	967	213	778	63
October 5.....	603	178	839	76	748	31
15.....	608	278	735	90	705	54
19.....	623 ^c	142	Died		712 ^c	41
26.....	719	343			705	143
November 2.....	775	325			779	178
9.....	743	255			733	161
16.....	725	189			745	158
23.....	768	185			791	335
29.....	783	375			804	213
December 7.....	814	366			811	251
14.....	904	346			852	299
21.....	954	454			875	261
28.....	1095	351			923	279
1930						
January 4.....	1010	339			880	223
11.....	1007	331			889	226
18.....	1053	369			896	260
25.....	1118	353			883	227
February 1.....	1153	361			913	250
7.....	1179	300			899	163
15.....	1162	402			890	229

^aGellan tuber alone.

^bStarted with 10 grams gellan tuber as supplement.

^cGellan tuber in place of rice.

TABLE 10

Showing weekly body weight and food intake of chickens with gallan tuber as source of anti-neuritic vitamin and carbohydrate

DATE	CHICKEN 4		CHICKEN 5		CHICKEN 6	
	Body weight	Food intake	Body weight	Food intake	Body weight	Food intake
	grams	grams	grams	grams	grams	grams
1919						
July 2.....	439		655		649	
6.....	408	45	609	57	616	101
13.....	326	55 ^a	569	69 ^a	548	99 ^a
20.....	371 ^b	100	593 ^b	141	594 ^b	137
27.....	327	100	692	235	617	213
August 3.....	326	79	694	207	605	183
10.....	296	66	679	113	598	140
17.....	285	66	651	188	600	187
24.....	Died		624	116	659	133
31.....			586	59	653	183
September 7.....			629	233	778	335
14.....			706	278	811	273
21.....			722	301	891	290
28.....			743	159	929	182
October 5.....			766	125	930	166
15.....			730	108	876	260
19.....			753 ^d	78	864 ^d	100
26.....			719	193	890	296
November 2.....			764	177	871	344
9.....			775	145	857	242
16.....			741	106	813	169
23.....			775	212	809	230
29.....			738	155	750	228
December 7.....			789	254	Died	
14.....			789	239		
21.....			817	209		
28.....			803	256		
1930						
January 4.....			788	225		
11.....			782	142		
18.....			839	300		
25.....			815	277		
February 1.....			879	213		
7.....			891	279		
15.....			887	325		

^aGallan tuber alone.

^bStarted with 10 grams supplement.

^dGallan tuber in place of rice.

TABLE 11

Showing weekly body weight and food intake of chickens with gallan tuber as source of anti-neuritic vitamin and corbohydrate

DATE	CHICKEN 9 ^a		CHICKEN 10		CHICKEN 11	
	Body weight	Food intake	Body weight	Food intake	Body weight	Food intake
	grams	grams	grams	grams	grams	grams
1929						
October 19.....	683		491		511	
26.....	602	82	463	197	549	249
November 2.....	572	100	427	103	507	130
9.....	600	110	410	116	436 ^b	57
16.....	569 ^b	150	345 ^b	29	443	62
23.....	554	106	411	129	437	84
29.....			426	146	421	56
December 7.....			481	183	396	46
14.....			462	111	371	27
21.....			451	100	434	32
28.....			489	110	368	104
1930						
January 4.....			543	182	318	30
11.....			527	144	Died	
18.....			478	103		
25.....			481	69		
February 1.....			435 ^c	19		
7.....			438	91		
			Died			

^aDied November 27, 1929 with a weight of 435 grams on November 25, 1929.

^bStarted with 15 grams supplement.

^cGallan tuber in place of rice.

TABLE 12

Showing weekly body weight and food intake of chickens with gallan tuber as source of anti-neuritic vitamin and carbohydrate

DATE	CHICKEN 12		CHICKEN 13	
	Body weight	Food intake	Body weight	Food intake
<i>1929</i>	<i>grams</i>	<i>grams</i>	<i>grams</i>	<i>grams</i>
October 19. . . .	575		588	
26. . . .	510	251	586	255
November 2. . .	565	212	552	145
9. . . .	626	189	488	92
16. . . .	622	182	512	109
23. . . .	520 ^a	80	448 ^b	48
29. . . .	428	6	458	61
December 7. . .	518	230	485	65
14. . . .	584	216	484	70
21. . . .	542	208	553	137
28. . . .	575	282	610	169
<i>1930</i>				
January 4. . . .	620	256	669	221
11. . . .	602	220	697	185
18. . . .	560	0	661	43
25. . . .	522	57	636	31
February 1. . .	443 ^b	19	603 ^b	62
11. . . .	474	201	663	144
15. . . .	422	51	615	199

^aStarted with 10 grams supplement.

^bGallan tuber in place of rice.

TABLE 13

Showing weekly body weight and food intake of rabbits with gallan tuber as concentrate

DATE	RABBIT 1♀				RABBIT 3♀	
	Body weight	Food intake	Body weight	Food intake	Body weight	Food intake
	grams	grams			grams	grams
1929						
July 30.....	642				644	
August 31.....	902 ^a				876 ^a	
September 7.....	1107	93 ^b			1065	66 ^b
14.....	1112	151			1116	135
21.....	1219	166			1175	161
28.....	1309	110			1268	93
			RABBIT 4♂			
October 5.....	1385	117	605		1341	134
15.....	1464	253	759	178	1388	214
19.....	1561	104	821	69	1490	100
26.....	1651	176	925	151	1577	114
November 2.....	1713	243	1078	187	1638	209
9.....	1718	260	1152	165	1688	157
16.....	1847	220	1296	182	1714	143
23.....	1885	265	1401	202	1805	221
29.....	1939	289	1515	208	1838	169
December 3.....	1991	169	1604	74	1902	103
14.....	2020	370	1719	443	1935	267
21.....	1988	222	1835	242	1978	195
28.....	1974	—	1860	—	1963	—
1930						
January 4.....	2007	340	1976	336	2004	300
11.....	2132	403	2047	296	1993	253
18.....	2223	356	2067	298	2001	262
25.....	2266	338	2141	292	2019	183
February 1.....	2262	—	2037	—	1935	—
7.....	2088	231	2124	228	2059	173
15.....	2166	270	2195	255	2092	231

^aInitial weights with fresh gallan tuber as supplement.^bGallan tuber (meal) consumed from September 3, 1929, to September 7, 1929.

TABLE 14

Showing weekly body weight and total food intake of guinea pigs with gallan tuber as concentrate

DATE	GUINEA ^a FIG 1 ♀	GUINEA ^a FIG 2 ♀	GUINEA ^a FIG 3 ♀	Total food intake
	Body weight	Body weight	Body weight	
	grams	grams	grams	grams
1929				
September 7..	295	311	335	
14..	308	317	344	250
21..	321	334	365	160
28..	349	369	399	290
October 5....	377	382	428	254
15....	338	380	418	204
19....	379	422	468	143
26....	422	476	509	218
November 2..	422	487	531	250
9..	427	499	545	312
16..	467	556	602	234
23..	473	617	648	279
29..	506	678	686	255
December 3..	503	686	686	157
14..	512	752 ^b	738 ^b	453
21..	508	521	608	226
28..	504	521	600	—
1930				
January 4....	549	549	635	317
11....	520	556	629	330
18....	561	637	695	363
25....	546	632	709	305
February 1...	483	562	694	—
7...	496	604	719	187
15...	496	667	760	219

^aAnimals were given fresh gallan tuber as concentrate in the early part of the experiment.

^bNo. 3 gave birth December 15, 1929 to one young, and No. 2 gave birth to two young on December 17, 1929.

COMPARATIVE EFFECTS UPON YOUNG RICE PLANTS OF DIFFERENT NITRATE SALTS IN COMPLETE CULTURE SOLUTIONS¹

BALDOMERO G. SALINAS

WITH FOUR TEXT FIGURES

Previous studies on the salt nutrition of the young rice plants show, among other things, that nitrogen is beneficial if supplied as nitrate of calcium and sulfate of ammonium, (Espino, 1920). Many of the other nitrate salts, especially those of the metals not essential to plants, had not yet been tried as sources of nitrogen for the young rice plant. Hence, they were tried in this study.

LITERATURE ON THE SUBJECT

Espino and Estioko (1931) reported that good growth of young rice plants was obtained from a culture medium containing 1 part monopotassium phosphate, $1\frac{1}{2}$ parts ammonium sulfate, $1\frac{1}{2}$ parts calcium nitrate and 4 to 32 parts magnesium sulfate with a total concentration of 0.002 gram-molecule (of all the salts taken together) per liter. It was also found that for normal development young rice plants require ammonium as well as nitrate; for in the absence of the nitrate, the plants showed a characteristic physiological injury—drying of the leaf tips.

In a series of experiments in which he tested the nutritive values of different kinds of salts supplied singly to young rice plants, Macasaet (1927)² found that among the nitrogen-bearing salts, ammonium nitrate, ammonium chloride, ammonium carbonate, and ammonium sulfate, were apparently not harmful; while potassium nitrate, ammonium carbonate, and mono-ammonium phosphate were apparently harmful. However, in pot experiments, Davidson and Le Clerc (1923) found that potassium nitrate, ammonium chloride, ammonium nitrate and magnesium nitrate had practically the same effect on the yield of hard winter wheat.

Trelease and Paulino (1920) compared the effects of different nitrog-

¹Thesis presented for graduation, 1928, with the degree of Bachelor of Agriculture from the College of Agriculture No. 418; Experiment Station contribution No. 822. Prepared in the Department of Plant Physiology under the direction of Dr. Rafael B. Espino.

²Macasaet, Emilio. Comparative study on the nutritive values of phosphates, sulfates, nitrates, chlorides, and carbonates of essential metals as indicated by the growth and development of young rice plants. *Abstract* in THE PHILIPPINE AGRICULTURIST 20: 552-553, 1932.

enous salts on the yield of an upland rice in soil cultures and found that the plants supplied with ammonium sulfate gave the highest yield; ammonium nitrate, second; sodium nitrate, third; and calcium nitrate, the lowest. Lipman, Blair, and Prince (1925) likewise found that ammonium sulfate, in the presence of lime, gave a higher yield of corn, oats, barley, and timothy than either calcium nitrate or sodium nitrate. Of the three nitrogenous salts tried, however, when added to a mixture of equal amounts of loam and sand, sodium nitrate gave the best yield of beets, (Schneidewind, Meyer, and Münter, 1920).

Sodium nitrate supplied to rice plants in pot cultures was found by Willis and Carrero (1922) to cause chlorosis and in the presence of mono-ammonium phosphate the chlorosis was more severe than when it was not used. While admitting that nitrate nitrogen supplied to rice produced chlorosis on rice in the early stage of growth, these authors reported that the yield was equal to that of plants supplied with ammoniacal nitrogen.

Attracted by the contradictory reports on the relative merits of ammoniacal and nitrate nitrogen, Kelly (1911) performed field trials and pot experiments. He found, among other salts, that ammonium nitrogen was the best for rice, and basing his conclusions on these findings, he recommends the use of ammonium salts, not nitrates, for rice plants and contends that the failure of rice plants in the presence of nitrate nitrogen is caused by the formation of poisonous nitrites. This conclusion, however, was not supported by the researches of Perciabosco and Rosso (1909). These investigators report that nitrites were absorbed by rice plants from culture medium without evidence of injury.

The reactions of nitrogenous salts with the soil and with other salts were observed by certain investigators. According to Shulov (1920), sulfate of ammonia as a source of nitrogen renders the insoluble phosphates in the soil more available than when sodium nitrate supplied the nitrogen. Kossowitsch (1904) reports that ammonium sulfate as a source of nitrogen in a culture medium gave an acidic medium in the course of plant growth. On the other hand, nitrates in the culture medium gave a basic reaction.

Few studies on the influence of nitrogen-bearing salts of rare metals on plants are reported. McHargue (1919) obtained an increase of yield in winter wheat from pot culture supplied with strontium nitrate. In culture solutions, barium nitrate retarded the growth of roots, stems, and foliage leaves of soybeans. At a concentration M/10,000, cobaltous nitrate appeared to exert a stimulating influence on the growth of rice (Roxas, 1911).

OBJECTS OF THIS STUDY

With the view of obtaining definite information on this phase of rice nutrition and to have definite knowledge on the comparative nutritive

values of many different nitrate salts when used singly or added to other salts in complete culture solutions, the present study was undertaken.

TIME AND PLACE

This investigation was carried out in the Department of Plant Physiology, College of Agriculture, Los Baños, Laguna. It was begun in April, 1927 and closed in January, 1928.

MATERIALS AND METHODS

Lowland rice

The plant. Seeds of rice were soaked in water for 24 hours and then washed thoroughly and spread between two pieces of moist blotting paper. After two days the radicle and the plumules were out. Seedlings that were apparently uniformly developed were selected and spread on paraffined bobbinet stretched over the mouth of a large museum jar filled with water. Eight days later, uniformly developed seedlings were selected and mounted on cork stoppers as described by Espino (1920).

The culture solutions. All the salts employed in this study were "Baker analyzed" and prepared singly in M/10 concentration, except the calcium sulfate which was M/200. The control culture (Espino and Palisoc, 1931)³, was made up of 1 part monopotassium phosphate, 1 part calcium nitrate, 1 part ammonium sulfate, and 8 parts magnesium sulfate. A trace of iron was added as ferric phosphate suspension.

In the test cultures, the original salt proportions in the control culture solution were modified. The calcium nitrate was not used. The calcium in this salt was replaced by the calcium of calcium sulfate and a nitrate of another metal was substituted for the nitrate radical. Each test culture solution was composed of 1 part each of monopotassium phosphate, a nitrate salt other than calcium nitrate; ammonium sulfate, and 4 parts each of magnesium sulfate and calcium sulfate. The culture solutions were prepared in three concentrations: 0.001, 0.002, and 0.004 gram-molecule (of all the salts taken together) per liter. The proportions and partial concentrations of the salts in the control and the test cultures are shown in table 1.

Whenever a culture solution was needed it was prepared as follows: A one-liter volumetric flask was first filled with about 500 cc. of distilled water. Then were added one by one the required amount of each salt, shaking the flask after each addition to prevent any formation of precipitate. In spite of this precaution, however, precipitates always formed in the culture solution which contained lead nitrate. For this reason, it was necessary before renewing the culture solutions containing lead nitrate, to rinse the roots and the culture bottles with distilled water.

³The experimental data were gathered some time in 1927; but the paper was not published until in 1931.

EXPERIMENTS AND RESULTS

Criteria of results

The different sets of experiments that were performed in this study together with the results obtained are given in different tables. The results are expressed under three criteria; namely, (a) external appearance of plants, (b) height of tops and (c) dry weight of top and root. The data under these criteria were obtained in the following manner:

a. *External appearance of plants.* From time to time the plants in the different cultures were observed and any new development was noted. Most of the notes, however, under this criterion were obtained at the time of harvest.

b. *Height of top.* The data under this criterion were obtained at the time of harvest, by measuring the height of the tallest leaf from its tip to the point of attachment of the seed to the stem. The heights of the two plants in each of the duplicate cultures were averaged; the averages from the duplicate cultures were further averaged.

c. *Dry weight of top and roots.* At the time of harvest, the two plants in each culture were removed from the cork stopper. Then the seeds were taken off, the plants wrapped in paper, and dried to constant weight in an electric oven at a temperature of about 100°C. After drying, the samples were weighed; the data under this criterion obtained from the two similar (duplicate) cultures were averaged.

Single salt cultures

The first set of the single salt cultures was conducted from July 28 to August 27, 1927. The cultures were in three concentrations 0.001, 0.002, and 0.004 gram-molecule; each containing potassium nitrate (KNO_3); barium nitrate ($\text{Ba}(\text{NO}_3)_2$); sodium nitrate (NaNO_3); lead nitrate ($\text{Pb}(\text{NO}_3)_2$); ammonium nitrate (NH_4NO_3); or strontium nitrate ($\text{Sr}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$). Each culture was run in duplicate. To be able to compare the results obtained from this set of cultures with those from another set, and test the suitability of the aerial environment of the plants for culture work of this nature, a four-salt complete and well balanced culture solution for the young rice plant was included in the set. This culture medium, for lack of a better term, is designated as *control*, (see table 1). The data obtained from the set of cultures which were in M/1000 concentration each are shown in the upper half of table 2. (Data from the higher concentrations are on file in the Department of Plant Physiology.)

Another set of the single salt cultures was tried from September 2 to October 2, 1927, in which were included, in addition to the four-salt culture solution referred to above (the control), the following nitrate salts: aluminum nitrate ($\text{Al}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$); cobaltous nitrate ($\text{Co}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$); cupric nitrate ($\text{Cu}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$); magnesium nitrate ($\text{Mg}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$);

nickelous nitrate ($\text{Ni}(\text{NO}_3)_2 \cdot 2\text{H}_2\text{O}$); zinc nitrate ($\text{Zn}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$), and chromium nitrate ($\text{Cr}(\text{NO}_3)_3$). Each salt was tried in three molecular concentrations, 0.001, 0.002, and 0.004, and each culture in duplicate. The data from this set of cultures which were in M/1000 concentration each are shown in the lower half of table 2. (Data from higher concentrations are on file in the Department of Plant Physiology.)

Owing to the fact that the data under each criterion from both sets were reduced to a common unit or basis, that is, in term of the corresponding results obtained from the control culture solution, the data in relative values from both sets are made comparable. Moreover, the results obtained from the control cultures in the two sets were so similar that the resulting relative values in table 2 are really comparable.

The complete culture solution

Cultures of the type A (see table 1) were first tried from November

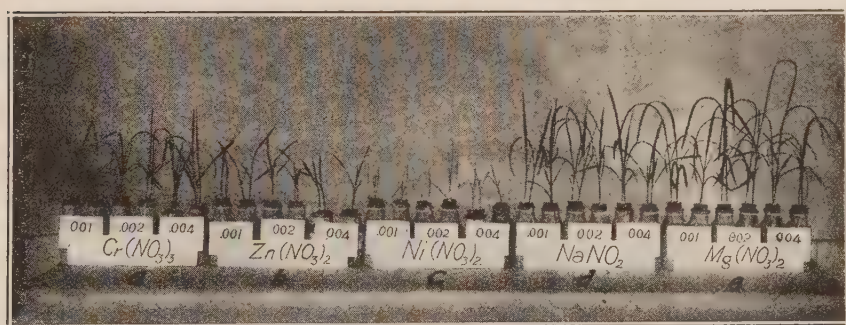


Fig. 1.—Young rice plants grown in complete culture solutions containing nitrates of different metals. Note the very harmful effects of $\text{Ni}(\text{NO}_3)_2$ and of $\text{Zn}(\text{NO}_3)_2$; $\text{Mg}(\text{NO}_3)_2$ was good and NaNO_2 was not very toxic to the plant.

15 to December 14, 1927. The second trial was made from December 30, 1927 to January 28, 1928. These cultures each had a total concentration of 0.001 gram-molecule (of all the salts taken together) per liter. But, owing to the fact that the results obtained from the cultures of the type A were similar to those in type A, the data for type A are not here published.

The first set of cultures of the type B (see table 1) conducted from October 14 to November 12, 1927 included a *control*, a four-salt solution. The second set of cultures of this type was run from December 30, 1927 to January 28, 1928 and included also a similar control culture. The data obtained after they had been reduced on the basis of the control cultures are comparable and are recorded in table 3; those under column I are for the first set or trial and those under II are for the second set or trial.

The two sets of cultures of the type C (see table 1) were simultaneously conducted from December 30, 1927 to January 28, 1928. The plants were

harvested and the data gathered. But, owing to the fact that the results obtained from this culture type were in general similar to those of type B, these data are not published here. They are on file in the Department of Plant Physiology.

Photographs of the second set of cultures of type B were taken at the end of the culture period, (see fig. 1-4).

DISCUSSION OF RESULTS

The results obtained from this study are here discussed under two main topics, (a) the effects upon the young rice plant of different nitrate salts used separately as single salt solutions and (b) results obtained from the experiments in which the young rice plants were grown in complete culture solutions supplied separately with different nitrate salts.

Owing to the fact that the height of top is not always an indicator of the true vigor of the plants, the nutritive values of the different cultures

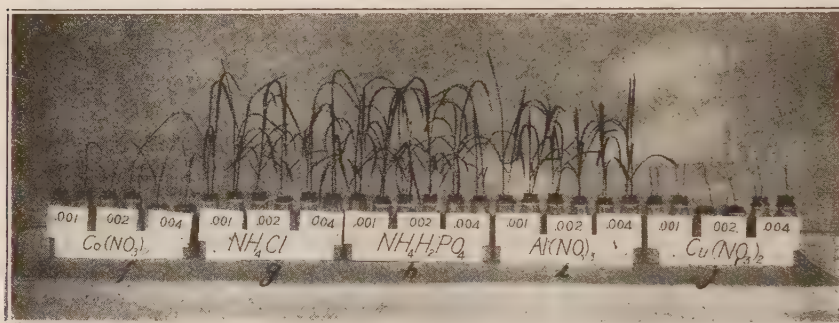


Fig. 2.—Young rice plants grown in complete culture solutions containing, among others, nitrates and ammonium salts. $\text{Co}(\text{NO}_3)_2$ and $\text{Cu}(\text{NO}_3)_2$ were decidedly toxic. The other salts, (shown on labels) were quite beneficial to the plant.

tried are here reckoned mainly in term of (a) the external appearance of plants and (b) dry weight of the plant. Also, the photographs of the plants in figures 1-4 plainly show the comparative merits of the cultures.

Comparative harmful or beneficial effects of nitrate

Examination of the data in table 2 (also data on file in Department of Plant Physiology) shows that, with a few exceptions, the lowest concentration tried gave the best results under the criteria here employed. For this reason, and in order to simplify materially the discussion on the results obtained, only the data under the lowest concentration (0.001 gram-molecule) are here considered.

As shown by the data in table 2, the best plants were obtained from the cultures supplied with sodium nitrate and ammonium nitrate. The data in table 2 also show that the plants which were able to live up to the

end of the experimental period were those grown in sodium nitrate solutions and those supplied separately with ammonium nitrate, aluminum nitrate, and magnesium nitrate,—indicating that these salts, in the three concentrations tried, were not severely toxic to the young rice plants. The plants which were found to be dying at the end of 30 days were those supplied with potassium nitrate alone, or strontium nitrate, or zinc nitrate. These three salts are, then, rather toxic to the plant. The nitrate salts relatively most toxic to the young rice plants were the nickelous nitrate and the cupric nitrate which killed the plants after they had been in the solutions only for 8 and 10 days, respectively. The other nitrate salts that killed the young rice plants during the 30-day experimental period were barium nitrate, after 19 days; cobaltous nitrate, after 20 days; and lead nitrate, after 25 days. Cobaltous nitrate in concentration M/10,000 was found by Roxas (1911) to exert an stimulating effect upon rice plant.

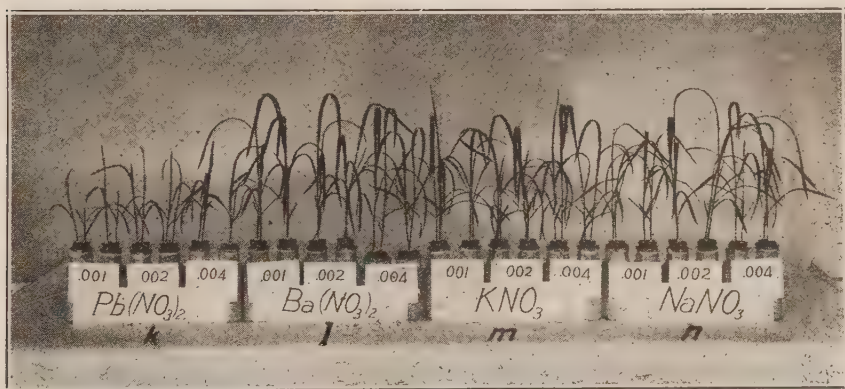


Fig. 3.—Young rice plants grown in complete culture solutions each containing, in addition to other salts, a nitrate. $Pb(NO_3)_2$ was rather toxic; while Ba, K, or Na-nitrate was beneficial to the plant.

Comparing the nutritive values of 13 nitrate salts when used separately in complete culture media

Owing to a difference in the general make-up of the culture solution which was used as control and of the *test cultures*, the results obtained from the control cultures are here employed primarily to determine the suitability of the aërial conditions for the normal development of the young rice plants. Luckily, the control cultures always produced normally developed young rice plants,—proving that the aërial conditions were suitable for the plant. Incidentally, the data from the control cultures, being from normally developed plants, may be considered as suitable standards with which to compare the results obtained from the test cultures. It should be said also, that the results from the test cultures check each other.

Judging from all the data (including those not published but on file in the Department of Plant Physiology) that were obtained from this study, with few exceptions only, the most suitable culture type, in term of dry weight of the plants, was type B, in which the total concentration of each culture solution was 0.002 gram-molecule (of all the salts taken together) per liter. The data in the tables show also that the good cultures, that is, the cultures (marked H in table 3) that gave decidedly high yields of dry tops and roots in cultures type B (0.002 gram-molecule) were the same ones that gave high yields of dry tops and roots in the two culture sets A (0.001 gram-molecule) and C (0.004 gram-molecule). Similarly, the cultures that killed and those that produced poorly developed plants in one culture type were about the same cultures that produced similar results in the other two culture types. For these reasons, it seems possible to confine further discussion only to the results that were obtained from



Fig. 4.—Young rice plants grown in complete culture solutions, each containing, in addition to other salts, a nitrate. Note the well-developed plants—indicating the beneficial effects of nitrate of NH_4 , Sr , or Ca . $\text{Ca}(\text{NO}_3)_2$ was present in the control.

culture type B, in which the culture solutions appear to be in the optimum concentration. This scheme is here followed and the study of the data on the relative values of the different cultures tested are simplified greatly.

Further examination of the data in table 3 in which the culture solutions each had a total concentration of 0.002 gram-molecule (of all the salts taken together) per liter, shows that the cultures marked H supplied with potassium nitrate, sodium nitrate, barium nitrate, and strontium nitrate produced good results under the criteria of height of top (also see fig. 3 l, m and n and fig. 4 p.) and dry weight of the plant in both trials. McHargue (1919) found strontium nitrate beneficial to winter wheat, but barium nitrate was harmful to soybeans. Calcium should also be included in the

latter group as calcium nitrate was present in the control culture, which also gave good growth to the young rice plant. These observations seem to suggest a generalization that nitrates of alkali metals (K and Na) and of alkaline metals (Sr and Ba; Mg and Ca) in complete balanced culture solutions are beneficial to the young rice plants. It should, however, be admitted that except in one trial of barium nitrate and under the conditions of this study, none of these nitrates produced plants which, in dry weight, were any better than those obtained from the control. In term of height of top, the control was surpassed by some of the culture tests.

The culture solutions that contained either ammonium nitrate or magnesium nitrate also produced rather well developed young rice plants, (see fig. 1 *e* and fig. 4 *o*). These results confirm similar results obtained by Espino and Palisoc (1931).

Examining the cultures that produced poor results, (see those marked *L* in table 3 and fig. 1 *c* and fig. 2 *f* and *j*) it may be seen that the cultures containing either cobaltous nitrate, cupric nitrate, or nickelous nitrate, killed the plants before the end of the experimental period. The well-known toxicity of copper salts manifested itself in this study, in which cupric nitrate in culture solution poisoned the young rice plants in 17 days in trial I and 6 days in trial II. But as stated in preceding discussion Roxas (1911) found cobaltous nitrate stimulating in its effect on rice when used in a very weak concentration, M/10,000.

The rest of cultures, that is, those that contained lead nitrate, aluminum nitrate, zinc nitrate, or chromium nitrate, produced plants low in dry weight and, except the aluminum nitrate and the chromium nitrate cultures, they also produced plants that were rather stunted in growth and chlorotic in appearance. The aluminum nitrate and the chromium nitrate cultures were rather peculiar. They exhibited a peculiarity characteristic of them in producing slender plants, (see fig. 1 *a* and fig. 2 *i*). Villa (1928) obtained similar results with nitrate of aluminum contained in complete culture solutions.

Additional observations

Incidentally, in addition to the various forms of nitrates, certain salts of ammonium were also tried. Sodium nitrite (NaNO_2) was also tried (see fig. 1 *d*). As these tests were not part of the main objective of this study the experimental data obtained from these cultures are not presented here. Only the pictures of the young rice plants supplied with the ammonium salts are shown in figure 2 *g* and *h*; figure 4 *o* and *q*. The control culture contained $(\text{NH}_4)_2\text{SO}_4$.

As shown by the illustrations referred to above, the young rice plants supplied with the complete culture solutions containing, among other salts, a salt of ammonium,—chloride, phosphate, nitrate or sulfate, were well

developed. This result indicates the beneficial effects on the young rice plants of any of the ammonium salts tested and corroborates a similar result previously reported by Palisoc (1928).

The young rice plants supplied with sodium nitrite (NaNO_2) (see fig. 1d) had a fair development, which seems to indicate that at least this nitrite is not very harmful to the young rice plant. This finding, in some degree, corroborates Perciabosco and Rosso's (1909) observation that nitrites are absorbed by rice plants from culture medium without evidence of injury.

SUMMARY OF CONCLUSIONS

1. When used alone as single-salt culture media NaNO_3 , NH_4NO_3 , $\text{Al}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$ and $\text{Mg}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ were slightly toxic to the young rice plants; KNO_3 , $\text{Sr}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$ and $\text{Zn}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ rather toxic, and $\text{Ni}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ and $\text{Cu}(\text{NO}_3)_2$, the most toxic. $\text{Ba}(\text{NO}_3)_2$, $\text{Co}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ and $\text{Pb}(\text{NO}_3)_2$ were also rather toxic to the young rice plants.

2. Nitrates of alkali and alkaline metals in complete culture solutions tested were beneficial to the young rice plants.

3. Ammonium nitrate and magnesium nitrate in complete culture solutions were likewise beneficial to the plant.

4. Cobaltous nitrate, cupric nitrate and nickelous nitrate in complete culture solutions killed the plants.

5. Lead nitrate and zinc nitrate in complete culture solutions produced chlorotic plants stunted in growth and low in dry weight.

6. Aluminum nitrate and chromium nitrate in complete culture solutions produced slender young rice plants.

7. Ammonium salts, such as NH_4NO_3 , NH_4Cl , $\text{NH}_4\text{H}_2\text{PO}_4$, and $(\text{NH}_4)_2\text{SO}_4$, separately present in a complete culture solution were beneficial to the young rice plants,—corroborating Palisoc's (1928) findings.

8. Sodium nitrite (NaNO_2) in a complete culture solution produced fairly well developed young rice plants.

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TABLE 1

Partial concentrations^a and proportions of the different salts employed in each culture medium

SALTS EMPLOYED	CULTURE SOLUTION			
	A	B	C	Control ^b
KH ₂ PO ₄	0.00009	0.00018	0.00036	0.00018
NH ₄ (SO ₄) ₂	0.00009	0.00018	0.00036	0.00018
CaSO ₄	0.00036	0.00072	0.00144	0.00018
MgSO ₄	0.00036	0.00072	0.00144	0.00144
A nitrate salt.....	0.00009	0.00018	0.00036	
Total concentration in round number..	0.001	0.002	0.004	0.002

^a The salts are in gram-molecule concentration.

^b Espino and Palisoc (1931).

TABLE 2

Data^a showing comparative nutritive values of different solutions of nitrate salts used singly in M/1000 concentration

MOLECULAR CONCENTRATIONS OF SALTS EMPLOYED AS CULTURE MEDIA	HEIGHT OF TOP	DRY WEIGHT OF TOP AND ROOT	APPEARANCE OF PLANTS
KNO_3	49	28	Chlorotic, stunted, dying at end of 30 days
$\text{Ba}(\text{NO}_3)_2$	39	24	Stunted; all died after 19 days
NaNO_3	69	68	Growing well, leaves pale green, drying at tips
$\text{Pb}(\text{NO}_3)_2$	41	30	Stunted, died after 25 days; leaves straight rolled
NH_4NO_3	57	42	Growing well; leaves green, narrow
$\text{Sr}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$	43	26	Chlorotic, old leaves drying at tips, plant drying at end of 30 days
Control	100 (30.8 cm.)	100 (0.1155 gram)	Well developed
$\text{Al}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$	53	31	Chlorotic, leaves narrow, long, drying at tips
$\text{Co}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$	34	24	Stunted, erect, died after 20 days
$\text{Cu}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$	27	20	Died after 10 days
$\text{Mg}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$	60	34	Chlorotic; with narrow leaves, drying at tips
$\text{Ni}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$	26	14	Died after 8 days
$\text{Zn}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$	38	30	Dying, brownish spots on leaves
$\text{Cr}(\text{NO}_3)_3$	32	22	Died after 12 days
Control	100 (29.4 cm.)	100 (0.1056 gram)	Well developed

^a The data are averages of duplicate cultures and in relative values, that is, the actual value from the control culture was arbitrarily taken as 100; the rest of the actual values under the same criterion were reduced relatively. The data in the upper half of the table were obtained from experiments from July 28 to August 26, 1927; those in the lower half of the table were for September 2 to October 2, 1927.

TABLE 3

Comparative effects on the growth of young rice plants by different nitrate salts separately present in complete culture media. (Data are in relative values,^a Trials I and II^b 0.002 gram-molecule of all the salts taken together, per liter.)

SALT USED TO REPLACE $\text{Ca}(\text{NO}_3)_2$ IN CULTURE MEDIA	HEIGHT OF TOP		DRY WEIGHT OF TOP AND ROOT		EXTERNAL APPEARANCE OF PLANTS
	I	II	I	II	
KNO_3	101H	101H	91H	78	Plants normal
NaNO_3	98H	109H	85	85	Plants normal
$\text{Ba}(\text{NO}_3)_2$	96H	102H	101H	81	Plants normal
$\text{Pb}(\text{NO}_3)_2$	72	57	46L	41L	Plants chlorotic, leaves dried at tips; roots many but short
$\text{Sr}(\text{NO}_3)_2 \cdot 4\text{H}_2\text{O}$	99H	104H	95H	89	Plants normal
NH_4NO_3	85	103H	97H	80	Plants green, old leaves dried at tips; roots many
$\text{Al}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$	71	66	44L	49L	Plants chlorotic, narrow leaves, dried at tips; roots few
$\text{Co}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$	52	43L	20L	20L	Plants stunted, died after 27 days
$\text{Cu}(\text{NO}_3)_2$	30L	25L	15L	17L	Plants stunted, died after 17 days
$\text{Mg}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$	82	118H	85	85	Plants normal
$\text{Ni}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$	47L	41L	18L	23L	Plants stunted, died after 24 days
$\text{Zn}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$	68	46L	47L	31L	Plants chlorotic, narrow leaves
$\text{Cr}(\text{NO}_3)_3$	75	66	42L	55	Plants chlorotic; roots few, brownish
Control	100H (41.4 cm.)	100H (28.3 cm.)	100H (0.249 gram)	100H (0.249 gram)	Plants normal

^aThe actual value for the control culture was arbitrarily taken as 100 and the rest of the actual values under the same criterion were reduced relatively.

^bTrial I was performed from October 14 to November 12, 1927; trial II was from December 30, 1927 to January 28, 1928.

ABSTRACT¹

An investigation of the Ventura system of compound clarification. ELEAZAR T. SITCHON. (*Thesis presented for graduation, 1931, from the College of Agriculture No. 419; Experiment Station contribution No. 823*).—The investigation was carried out in the laboratory of the Pampanga Sugar Development Co., Inc., at San Fernando, Pampanga, Philippines, from January 1930 to February 1931. The object of the investigation was to find out the nature and working of the Ventura system of compound clarification; its advantages and disadvantages as a new process.

The Ventura system of compound clarification was compared with two other methods of clarification; namely, the ordinary method or common method, and the hot liming method. The Ventura system consists of liming the juice in two doses; first, in the cold to a pH of 6.1 to 6.4 and second, in the hot to a pH of 7.4 to 7.8. The heating temperature is between 212°F. and 220°F. The ordinary method or common method consists of liming the juice in the cold to a pH of 7.4 to 7.8, and heating in baffled juice heaters to a temperature between 215°F. and 220°F. The hot liming method consists of first heating the juice to boiling and then lime is applied.

Twenty duplicate samples of mixed juice and clarified juice were obtained from the factory during actual running conditions and then the following were determined: pH, clarity, colloids, sucrose, glucose, rate of settling, increase in purity, recovery of sucrose and filtration rate.

The Ventura system of compound clarification operates on the principle of fractional precipitation on definite pH values based on the behavior of the colloids. It gives the same gravity purity from the mixed juice to the clarified juice as the common method, but it was difficult to get good clarity and sugar of good refining quality by the common method.

The Ventura system removes the greatest amount of colloids and gives better clarification than either of the other two methods. As to the recovery, the common method has a slight advantage over that of the Ventura system; the hot liming method showed a decidedly poor recovery. To get the same quality sugar, the Ventura system has less inversion losses than the hot liming method. The rate of settling is practically the same for all the three methods. Settling is most rapid for the first thirty minutes, from which time it proceeds slowly.

The Ventura system appears better than either of the other two methods except for the large amount of scales formed in the heaters. To change from the common method to the Ventura system of compound clarification there is no additional expense for equipment.

—*Abstract by Nazario Pidlaon.*

¹Abstract prepared as part of required work in English 3a, College of Agriculture.

CURRENT NOTES

There has been in past years considerable time, money and effort spent on conducting live stock judging competitions for boys and girls. From present indications it is most likely that this practice will continue. . .

Strictly speaking these judging classes have been organized for the boys and girls as a means of developing in these young people a keener interest in live stock, and simultaneously to increase their powers of observation so that they may discern more accurately the good from the bad.

—*The Journal of Agriculture and Horticulture*, (Quebec), August, 1931.

The problem of the relationship of rice to Beri-beri will not be specifically discussed here but certain aspects of the defects of polished white rice will be briefly considered.

Fashion is so contagious that even the poorest man is anxious to use highly polished spotless white rice if he could only secure it. It is no exaggeration to state that the opulence and the extent of refinement of a man is partly measured by the quality of the rice he uses. Little do we know what valuable nutrient materials are lost in the polishing. The greater the polish, the greater is the loss. The fats, proteins, mineral salts and vitamins are stored in the outer, dirty brown or red coating of the rice grain, and during the process of polishing these nutritive constituents are lost and all that remains is mostly starch.

Analyses in the laboratory and feeding trials with pigeons have shown that raw-milled, unpolished rice is the most nutritious, while raw-milled, highly polished rice is the least nutritious. Parboiled rice comes midway between these two extremes. Parboiled and milled rice, in the unpolished stage, is not so nutritious as raw-milled and unpolished rice; but even when it is polished, boiled rice possesses a higher nutritive value than the corresponding raw polished rice.

Washing of rice just before cooking has also been found to deprive rice of a good deal of its most nutritious ingredients. The effect of draining rice after cooking should also be similar.—*The Madras Agricultural Journal* Vol. XVII, No. 11. Reprinted in *The Journal of the Mysore Agricultural and Experimental Union* No. 3, 1930.

In the year 1925, Mr. Wincenty Matzka, a well-known Polish chemist and inventor, who was living in London at the time, made a discovery which it is claimed is of the greatest benefit to humanity. He found that when fruit or vegetable juices are passed slowly between different metals, set closely to one another, by a special thermo-coupling arrangement, a

reaction between these metals is set up which has the effect of destroying the bacteria of fermentation, putrefaction and disease. These juices may then be kept in this natural form for an indefinite period, and can be transported. No added preservative is required.

It was first thought that the reaction described above was of an electrical nature only, but further study on the part of the discoverer and of American and German scientists has indicated the existence of a natural force, previously unknown, which was claimed as the Oligo-Dynamic action of Metals, supposed to be the action by which noble metals act as "Cosmic Ray" condensers. The metals used cannot be attacked by fruit juices, consequently no metallic taste is found in the latter.

The first cost of a "Matzka" System installation is very moderate, and the cost of operating per gallon is so low as to be almost negligible, as the passage of the liquid through the apparatus, occupying about 6 minutes, is effected by gravity.

—*Tropical Life*, May, 1931.

Since the imposition of a prohibitive tariff against the importation of various kinds of fruits into Egypt, the export trade in pomegranates from Cyprus to Egypt has received a severe blow...

Since the imposition of the new Egyptian tariff, an exploration of the possibility of establishing markets elsewhere than Egypt, has been made and all possible avenues for the marketing of either the fresh fruit or the expressed juice have been investigated...

The importation into the United States of America of pomegranate fruit is prohibited from all sources but this prohibition does not apply to pomegranate juice.

Pomegranates are grown and consumed in California, but pomegranate juice does not appear to be used to any considerable extent. A high class foodstuffs importing firm of New York has expressed interest and there are possibilities of developing trade in pomegranate juice for the manufacture of fruit syrups and extracts. Arrangements are in hand to forward samples for examination and report.

—*The Cyprus Agricultural Journal*, September, 1931.

A first-hand study of the artifacts left by early man leads to the conclusion that all the cultures of the world, even including that of the American Indian, are the result of a process of evolution and have some single origin. At least such is the judgment of Dr. H. S. Harrison, curator of the Horniman Museum, as expressed in a report just submitted to the British Association for the Advancement of Science.

Man is not capable, said Dr. Harrison, of inventing some previously unconceived instrument or method to fit an ideal purpose. "The plough," he said, "was not invented as a means of efficient tillage, but was the result of the discovery that a pick or a hoe could be dragged through light soil so as to prepare a seed bed more rapidly than could be done by packing up the soil; the implement got a new start in life by a change in the method of use. . . . At no stage was there a premonitory vision of a method of agriculture, or a type of plough, having an origin in a mental conception cut off from its roots in the state of knowledge of the place and time. That kind of unconditioned foresight does not happen even now-a-days, and we may assume it never will."

—*Science.*

COLLEGE AND ALUMNI NOTES

The Committee on Resolutions and Recommendations from the First Rural Institute in its report expressed appreciation of work done by the dean and faculty of the College and of the hospitality of Rev. and Mrs. Hugh Bousman. Among the recommendations of the Committee were the following:

That every local church should organize a Committee on Economic Improvement for the purpose of helping not only the members but also the people of the community and of coöperating with the N. C. C. as well as government representatives in the campaign for the development of rural work.

That the N. C. C. negotiate with government authorities through the Rural Work Committee for the arrangement and development of a system of rural life institutes having the Los Baños Agricultural College, rural high schools, and local barrio meetings as the principal activities.

That a campaign be launched to educate our communities with the coöperation of the Philippine Health Service and other health agencies for the betterment of our sewerage system and for the general use of the improved Antipolo system throughout the Philippines.

That we request the N. C. C. and the American Bible Society to utilize the Bible Truck, not only for the distribution of Bibles, but also of good selected seeds, cuttings, and other agricultural articles needed by the people in rural communities.

That we express our appreciation and pledge our coöperation in the campaign championed by Governor-General Roosevelt against usury in the Philippines and ask our legislature to improve our land laws, especially by the abolition of "Pacto de Retro."

At the request of Mr. Paulino Santos, the Director of the Bureau of Prisons, Professor I. Elayda and Dr. L. G. Gonzalez of this College together with Mr. F. Galang of the Bureau of Plant Industry accompanied him on an inspection and reconnoitering trip to the Davao Penal Colony. They were gone from April 18 to May 6. They stopped at Zamboanga to visit the San Ramon Penal Colony.

The new penal colony in Davao is right in the heart of the jungle but is accessible by water and offers good possibilities for road connections with the provincial highway. The area is a little over 28,900 hectares, all level and said to be one of the most fertile spots in Mindanao. Within the reservation are places admirably suited for various kinds of plants, from aquatic plants to highland crops. Director Santos' plan is to raise on this reservation enough staple food crops to feed 10,000 Insular prisoners. In a little over two months, under direction, 50 prisoners have cleared 150 hectares of heavily forested land.

On April 11, Robert L. Pendleton, professor of soil technology, returned to the Campus after spending eleven months on leave in China. During this period Doctor Pendleton was chief soil technologist of the National Geological Survey of China, with headquarters in Peiping. His task was to train a staff of soil surveyors and soil chemists, to develop a soils laboratory, and to make soil surveys. The typical and widely scattered areas studied were around Peiping, on the edge of Inner Mongolia, in Northern Manchuria, and around Nanking and Hangchow. In addition, much progress was made in developing coöperative soil research for China as a whole.

Returning to the Philippines Doctor Pendleton travelled from Northern China *via* Kobe, Japan. He visited Dean Baker's grave in the beautiful and peaceful temple grounds at Sayemura, Tatsuno, about 75 kilometers west of Kobe.

Assistant Professor Anne Cole of the Department of English returned to the Campus June 1 from a year's vacation. Miss Cole returned to the United States in 1931 *via* Europe arriving in New York in September. She spent the winter with her mother in Long Beach, California. While in Long Beach, she entered the University of California, L. A. for special courses in literature and dramatic production.

The College Physician, Dr. Sixto Francisco, sailed June 5 for Honolulu. Doctor Francisco is the official delegate from the University of the Philippines to the Pacific Regional Health Conference of the World Federation of Education Association which meets in Honolulu from July 25-31. On their way to Honolulu, Doctor and Mrs. Francisco stopped a few days in China and also in Japan. After the Conference they will go to Los Angeles for the World Olympic Games, August 1-16. Doctor Francisco will make special effort while in the United States to investigate effects on students of competitive athletics.

Mr. Fernando de Peralta, B. Agr., '19; B. S. A., '22; M. S., '23, for several years instructor in Plant Physiology, sailed for the United States on May 7, 1932. Mr. Peralta will take graduate studies in the University of Nebraska, majoring in plant ecology.

Mr. Nicolas Galvez, instructor in Agricultural Chemistry, sailed April 5 on the *S. S. Derfflinger* for Germany. He is planning to take advanced work in Agricultural Chemistry in Göttingen University.

A letter was recently received by Doctor Pendleton from Mr. Victor Buck, who for ten years or more has been engaged in rural mission work. He is now in Belgian Congo, West Central Africa. In his letter Mr. Buck comments on the crops he is introducing in the villages. In view of our Rural Life Institute last March these comments may carry special interest for us. J. Lossing Buck, Professor of Economics in Nanking University, is a brother of Mr. Buck. An extract from the letter follows:

* * * I am planting everything I can lay my hands upon and shall distribute as I get stocked up on seed.

I have known of the pigeon pea for a long time, but am becoming more and more convinced that it has a place in tropical agriculture as a food for man as well as for a green manure and soil improving plant. With large gardens of them one can have food all through the dry season. They plant many cowpeas here and it is one of their principal foods, but it dies down of course with the approach of the dry season.

Our soil is very sandy here, so it is necessary to turn under crops or grass and the like for green manure, to add humus to the soil so that it will hold moisture during the dry season, especially for such crops as bananas, and the taro. How extensively is the taro used in the Philippines? It surely is a wonderful food plant when one gets to know it and how to use it. I have had to introduce it here, but now have over a thousand plants of it. Another year I shall have thousands, and will be ready for distributing I hope.

More and more every day I am finding new uses for the banana. With it I make a whipped cream substitute, marmalades, jam or jelly without using any sugar. The flour from it is invaluable for pastry cookery. It makes wonderful cookies and pancakes even without the addition of any other white flour. Less sugar is required when using it and less milk. One can make a gruel from it that reduces the amount of milk required one half in some recipes.

Cassava flour too has a wonderful place in cookery. The starch made from it is better than cornstarch for puddings and thickening purposes. What is left from making starch makes the best flour, which can be used one-fourth to one-third in making bread and biscuits. I use it continually in pastry cooking.

I am planting much roselle this year for making jelly from. I suppose you have eaten roselle jelly, as it was there in the Philippines that I first heard about it.

As for adlay, I have some seed at last sent me from Cameroun and am trying to get enough to make flour and rice substitute, porridge and the like. I found it just wonderful in making pancakes. * * *

IWAHIG PENAL COLONY: THE LARGEST FARM IN THE ISLANDS¹

On the invitation of Colonel Paulino Santos, Director of Bureau of Prisons, the writer accompanied him on a recent trip of inspection of the Iwahig Penal Colony. The other members of the party were Dr. N. B. Mendiola, Head of our Department of Agronomy, and Mr. Victorino Borja, rice specialist of the Bureau of Plant Industry. The party left Manila on the *M. S. Fortuna* on May 22, arriving at Puerto Princesa, Palawan, on May 26, and left the same port May 31 on the same boat, arriving in Manila on June 2.

The colony is situated in Palawan Island about 20 kilometers south and east of Puerto Princesa, the capital of the province. This province comprises the main island, Palawan, and neighboring islands, the most important of which are the Calamian group, Cuyo group, Dumarang, Cagayanes and Balabac.

The immediate object of the trip was to look into the present farm practices of the colony with a view to suggesting possible improvements. The basic objective was to suggest ways to increase the productivity of the colony so as to make it not only largely self-supporting but also to produce in it the food stuffs required by Bilibid Prison in Manila, the central penitentiary in the Islands. Accordingly, Doctor Mendiola concerned himself with field and orchard crops, Mr. Borja with upland and lowland rice, and the writer with the live stock problems of the colony.

To give an idea of the size and activities of Iwahig Penal Colony the following figures are quoted from a memorandum prepared by the Colony officials for the occasion of the anticipated visit of Governor General Roosevelt to the Colony on May 30, 1932.

FACTS AND FIGURES

I.	Founded in November 16, 1904 by His Excellency, Governor General W. Cameron Forbes. Mr. R. J. Shield, First Superintendent.	
II.	Area 46,871 hectares, estimated.	
III.	Population:	2356
	Officers and Employees.....	18
	Employees from other Bureaus.....	5
	Families of Officers and Employees.....	72
	Colonists.....	2027
	Families of Colonists.....	233
	Free Colonist.....	1

¹General Contribution from the College of Agriculture No. 311.

IV. Agriculture:

105,126.00 coconut trees (76,551 bearing)
 323.62 hectares of lowland palay
 160.00 hectares of upland palay
 153.50 hectares of corn
 65.25 hectares of sugar cane
 141.00 hectares of cassava root
 63,372.00 hills of bananas
 3.50 hectares of pineapples
 1.75 hectares of camotes (sweet potato)
 99.50 hectares of legumes
 25.00 hectares of vegetables

Fruit Trees:

791	mango trees	873	namka trees
403	orange trees	46	tamarind trees
43	santol trees	87	guayabano trees
23	chico trees	1198	cacao trees
2053	coffee trees	4063	kasoy trees
11216	kapok trees		

V. Live stock:

1300 head of cattle (760 breeding and 640 work) all pure and grade
 Nellores
 429 head of carabaos (203 breeding and 226 work)
 25 head of horses
 141 head of swine and 451 privately owned by the colonists
 57 head of goats
 96 chickens and 6621 privately owned by the colonists
 37 turkeys
 11 ducks
 Over 500 hectares of pasture land

VI. Fishing:

3 fish ponds
 9 fish corrals
 3 fish nets, large
 Salt beds with a capacity of 25 sacks per day during dry season

VII. Edifices:

Estimated value..... ₱450,000.00
 Administrative Building, Recreation Hall, General Hospital,
 Public School, Officers' and Employees' quarters, Col-
 onists' dormitories, Quarters for Colonists' families, 2
 Churches, etc.

VIII. Health and Sanitation:

There are separate hospitals for men and for women and tuberculosis stations
 (T. B. Camps). Sanitary Inspectors are detailed throughout the Colony
 under the direct supervision of the Colony physician and a nurse. The
 average daily patients in the hospital is 60. There are 95 T.B. patients
 in the Kamagong T.B. Camps.

IX. Conveniences:

A first class pier
 A telephone system, covering the entire Colony
 A post office operated and maintained by the Bureau of Posts and the Colony
 A cold storage and ice plant

- Two hospitals, one for men and one for women
- Elementary school for all grades
- Electric light plant
- Water system
- Sewerage system (partial)
- Brick and lime factory
- Sawmill
- Machinery plant
- Sugar mills
- 3 rice threshers
- Rice and corn mills
- 96 bull carts, 1 automobile (Ford), 4 trucks, 4 motorcycles, 6 launches
- A cinematograph
- Well organized band and orchestra
- Weather observatory
- X. Industrial Activities:
 - Soap Factory
 - Coconut Candy Factory
 - Oil Factory
 - Nipa Sewing Section: Making nipa shingles, salacot, calapiao, baskets, straw and guinit hats, and sawali
 - Shoe and tailor shops
- XI. Roads and Bridges:
 - 29 kilometers of first-class road
 - 8 bridges with concrete bases
 - 17 bridges of strong materials (not cemented)
 - 180 culverts
- XII. Courts of Justice:
 - Justice of the Peace Court (Superintendent)
 - Summary Court (Superintendent)

These data establish as a fact that the largest farm in the Islands is Iwahig Penal Colony. As may be noted there are only a few civilian officials in the administration, so that the bulk of the work including administration and policing is performed by the colonists themselves. The colonists live in stations close to their fields of work. There are about twenty of these stations scattered over a wide territory, under the immediate direction of petty officers, who are colonists, also. The writer wondered how it was possible to so manage this immense farm or rather community. Inquiry revealed the following fundamental details:

1. Each convict must first serve one-third of his term under the strict discipline of Bilibid Prison.
2. Only convicts with excellent records for behavior are sent to the Colony.
3. When a convict is sent to the Colony the term prisoner is dropped and he is thereafter called a colonist. He also sheds the typical striped clothing of a convict and dons a civilian uniform.
4. Colonists may have their families live with them, the Colony bearing the expense. But after the colonist by good behavior becomes established

as a *settler*, he supports his family by his own labor as a farmer on land assigned him as a tenant with the Colony as landlord.

5. There is a "good conduct time allowance" equivalent to one-third to one-half of the full sentence. Life imprisonment is rated as thirty years, so that a well behaved convict by this system may serve ten years of his sentence in Bilibid, another ten years or less in the Colony, and then he is a free man once more.

Under these conditions there is little temptation to deviate from the straight and narrow path of good behavior.

We were informed that criminal acts committed in the Colony are much fewer than in a civilian community of similar size. The Colonists, after experiencing the closely confined life in Bilibid, appreciate the privileges and relative freedom they enjoy in the Colony.

The College of Agriculture is taking a very important part in the administration of the Colony. Of the eighteen employees, five are graduates of the College; they perform the following functions:

Pedro S. Paje, B. Agr. '27, Acting Assistant Superintendent and Supervisor of Agricultural projects.

Pascual Robin, B. Agr. '27, Chief of the Division of Horticulture.

Candido L. Bagaoisan, B. S. Agr. '31, Chief of Division of Agronomy.

Claudio L. Arellano, B. S. Agr. '30, Chief of Cattle Raising Division and Inagawan detached Station.

Pascual Andres, B. S. Agr. '32, In Charge of Poultry, Swine and Dairy Stations.

These men are doing important work and performing it excellently. Their Alma Mater may well feel proud of them. In the words of Colonel Santos, himself, who is a practical agriculturist and a born leader of men, the presence of young college graduates in the Colony has been an inspiration to the colonists and a potent factor for good. Colonel Santos has great faith in our graduates, and a more enthusiastic booster of the work of the College can not be found.

We found the Colony very well planned and efficiently administered. There is, of course, room for improvement in details in the systems of handling crops and live stock. For the healthy morale of the Colonists and the successful operation of the Colony credit is due the Director, Colonel Santos, the Superintendent, Captain E. B. Misa, and Lieutenant Liwanag, the Acting Superintendent at the time of our visit. All of these men were former Constabulary officers and they brought to their present work their experience in handling an effective organization.

B. M. GONZALEZ

Dean, College of Agriculture

CURING PORK AND MAKING SAUSAGE FOR HOME USE¹

MARIANO MONDOÑEDO

Of the Department of Animal Husbandry

Preserving pork for future use should be a common practice in Filipino homes. The process of curing meat and of making sausage is simple, requiring careful attention rather than work. It is not only a convenience to have cured pork in the larder, but it is an economical practice. Moreover, it is an aid in maintaining a good daily diet for the family.

Some of the most important benefits from a general practice of curing pork are:

1. At a minimum cost one can provide himself and his family with meat throughout the year.

2. Surplus meat if preserved and stored provides an emergency supply.

3. Having in stock cured pork and sausage enables a housekeeper to vary the meat in the meals.

4. When a hog is killed, if part of the carcass were preserved so it could be used over a period of time instead of then being wasted through spoiling and over-eating, it would tend to stabilize the hog industry.

5. The importation of preserved pork would be greatly reduced, and possibly the price of pork be lowered.

6. Meat raised under insanitary surroundings would disappear from the market.

7. Curing pork would encourage thrift and economy; would improve daily diet and in some cases reduce family meat bills.

The constantly increasing number of requests for information about meat preservation seems to indicate that our people are realizing the importance, indeed, the necessity for curing pork and thus conserving their meat supply. Anticipating this need, efforts in this College have been made to determine ways and means of curing meat which could be recommended for use in the average home. Some good results have been obtained from trials made recently on curing pork and particularly in sausage making. These results are presented in this circular.

SELECTION OF HOG FOR SLAUGHTER

To produce first class cured pork the animal to be butchered should be carefully selected.

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Health. In selecting an animal for slaughter its health is foremost in importance. A hog that is gaining or, at least, not losing in weight and is free from tuberculosis or any disease dangerous to man is considered from the health standpoint fit for slaughter.

Age and size. Pigs that have been rapidly grown and fattened turn out the best products. As a basis for selection, a one-year old pig weighing 80 kgm. should yield suitable meat.

Type and breed. The type of pig that seems to meet the requirements of the butcher and consumer is intermediate between what are called the ham and bacon types. That is, it should not be extremely blocky, the ham type, nor rangy, narrow and shallow-bodied, the bacon type. This intermediate type is found among the Berkjala, an improved native breed.

Condition. The average Filipino housewife prepares pork for the table without trimming off any part, if possible. The reason is that usually she cooks pork with vegetables. She, therefore, prefers pork from animals that are slightly below prime condition or finish. But for those who wish to roast or boil or fry the pork the best animal to produce meat suitable for these ways of cooking is one in medium to high condition. That is about a year old and weighing around 100 kgm.

Quality. A fine quality of meat is, largely, the result of breeding, of the method of feeding and management and of the sex and age. The best quality of meat is obtained from early maturing barrows or gilts that are plump and evenly covered with flesh and fat, with evidences of refinement in hair, skin and bone.

SLAUGHTERING THE HOG

Preparation before killing. The animal should be fasted 18 to 24 hours before killing, but should be given clean fresh water to drink. This treatment will help to free the blood and tissue cells from freshly assimilated substances which weaken the keeping quality of the meat. The reason for this is that the animal will bleed more freely and completely, hence the meat will be more wholesome; and in curing it will more readily absorb the ingredients used.

While fasting, the hog should be kept in a pen or crate in a quiet place close to the butchering place. If this is done, there will be little or no struggling or rough handling in catching and sticking the pig. The harmful effect of the struggling is that it raises the body temperature and the blood vessels may remain dilated and congested with blood after killing. Bruised parts of the flesh are really diseased and are therefore not wholesome. If the meat is cured these parts serve as points for souring or putrefaction to set in.

Time to slaughter. The best time of the day to slaughter a hog for curing purposes under ordinary temperature is late in the afternoon so that the meat can cool thoroughly during the night. The best time of the year

to slaughter when meat is to be cured under ordinary temperature is during the cool season; that is, between November and February. Of course, if artificial refrigeration facilities are available hogs may be slaughtered any time that is convenient.

Manner of sticking. One object to be kept in mind in sticking is to secure a thorough bleeding. This can be accomplished by sticking the animal so that the two principal arteries on each side of the neck are severed at the point where they unite, which is in the region between the first two pairs of ribs. The point of the knife with the sharp edge away from the neck is placed about four centimeters in front of the breastbone, then pushed in between the first pair of ribs at their junction with this bone until the point of the knife has penetrated seven or eight centimeters. Then the point of the knife with the sharp edge now toward the neck is thrust directly downwards to the neck at its junction with the backbone. In this manner the two large blood vessels are cut, leaving the heart uninjured to pump the blood out.

The method of slaughter used at the College is to tie one of the hind legs with a short piece of rope with a loop at the free end. This loop is tied to a long piece of rope and with a block and tackle the animal is hoisted to a convenient level. The advantages of this method is that there is no struggling with the pig, thorough bleeding is secured and one man can perform the whole operation.

Dressing the carcass. The most approved way of scalding is by immersion. The temperature of the water for scalding should be between 65° and 70°C. (149° to 158°F.). The right temperature may be approximately determined by dipping a finger in the water. If the finger can be put in the hot water three successive times but not a fourth, the temperature is just right; if it can be put in the fourth time the water is not hot enough. Heat the water more or add cold, as the case may be, until the temperature is right. It is important that it be just right. If the scalding water is not hot enough the carcass has to be immersed so that the heat penetrates enough to slightly cook the meat on the outside; such meat will not cure well. If it is too hot the hair loosens rapidly but will set again faster than it can be scraped off and it can not be loosened again by repeating the scalding.

A barrel or a large vat, *kawa*, may be used for scalding. In case the carcass is too large for the barrel, the fore half may be immersed and the hair and scurf scraped off and then the hind half may be treated likewise. The carcass should be kept under water until the hair can be rubbed off with the hand. Keep the carcass moving in the hot water so it will receive a uniform degree of heat. Scrape off the hair the way it lies, not in the opposite direction. The hardest parts to scrape are the head and shanks; these should receive the first attention.

After the whole carcass has been scraped clean, rinse it with hot water; shave off any remaining hair with a sharp knife; finally rinse with cold water and dry the surface by scraping it with the back of a knife.

Remove the internal organs as quickly as possible to prevent the odor of their contents spoiling the flavor of the meat. Avoid soiling the dressed carcass, for meat should not be washed before curing.

CURING THE PORK

Selection of cuts. When meat is cured under ordinary temperature throughout the process, it must be cut into small pieces ($\frac{1}{2}$ to $1\frac{1}{2}$ kgm.). The best parts to select are cuts where the lean and fat are firmly held together. Such cuts may be found in the shoulders, rump, ham, sides and the jowl. When a refrigerator is available any part cut any size that it will accommodate may be cured.

For curing under atmospheric temperature, cut off the pieces selected as soon as possible after dressing the carcass.

Cooling the meat. It is absolutely essential that no animal heat be in the meat when it is placed in the brine. Only thoroughly cooled meat will turn out firm in texture when cured. When not cooled to as low a temperature as 25°C. (77°F.), the cured meat may be good but the texture will be soft, pulpy and greasy. The best place for cooling the meat is under shelter, open on all sides to admit free circulation of air. The pieces of meat should be hung separately so they will not touch. About six to eight hours for the meat to cool under ordinary temperature is generally sufficient. Just before putting the meat to cure, trim the pieces with a sharp knife so as to secure clean cut surfaces with the edges and corners rounded.

When a refrigerator is available, large pieces should be cooled for 18 to 24 hours. Where a cooling room can be used it is advisable to cool the meat in split carcasses.

The best temperature for cooling the meat ranges between 2.2° to 3.3°C. (39.2° to 41.1°F.). The meat cured successfully at the College was cooled from 36 to 48 hours and stored while in the curing liquid at temperatures ranging from 3.9° to 7.2°C. or (about 45.7°F.). Do not attempt to cure meat that has been frozen.

The curing ingredients. The principal preservatives are common salt and saltpeter. Sugar is used to impart a desirable flavor and to neutralize the hardening effect of the salt; water is used as solvent for the solid ingredients. Other ingredients, such as pepper, nutmeg, cinnamon, etc., may be added to suit individual taste.

Common salt is the basic preservative. When used alone, however, it hardens the meat, removes its natural color, and produces an insipid salted product. Saltpeter is used chiefly to preserve the natural flesh

color of the meat. Baking soda may also be added to help keep the meat from souring.

Formula for curing. To find methods of curing pork that may be used generally and under a variety of conditions, the author tried several ways and different recipes. Each recipe was tried repeatedly under ordinary temperature, artificial refrigeration, brine cure, dry cure, and dry-brine cure methods. Only the methods that yielded uniform success and the recipes that turned out successful products are reported in this circular.

For every 100 kilograms of meat to be cured under ordinary temperature the following recipe for making the brine is recommended:

25 kgm. of common salt
5 kgm. of sugar (brown or white)
.3 kgm. of saltpeter
.1 kgm. of baking soda (sodium bicarbonate)
100 liters of water.

For curing ham, that is, the thigh or shoulder, under refrigeration, the recipe recommended by Helser gave the best results. This recipe for every 100 kilograms of meat is as follows:

12 kgm. of common salt
3 kgm. of sugar
125 grams of saltpeter
50 liters of water

To make the brine, dissolve the solid ingredients in the water and boil from five to ten minutes. Strain out the impurities and make up the solution to the necessary amount by adding boiled water. Allow the brine to cool.

Packing the meat in the brine. The following containers have been found satisfactory. For small quantities, the common earthen vessels, the *camao* and *palayok*; for larger quantities, the *tinaja* or *tapayan*, both of which are common earthen vessels. Any wooden container the wood of which will not impart a disagreeable flavor to meat may be used. It is not advisable to use metal vessels as the action of the salts in the brine on the metal may spoil the flavor or color of the meat.

After the container has been thoroughly cleaned, scalded and cooled, pack in the pieces of meat with the flesh side up, except those that make up the top layer; these should be laid with the skin side up. Pack in the large pieces first, then the small ones. Put a weight (flat stones, plates, or a piece of board) on the meat sufficient to prevent the pieces from floating. It is a good plan to place bamboo slats under the weight. Finally, pour the brine which should be as cool as possible slowly over the meat. Every part of the meat must be kept well covered with brine at all times during the curing process.

When a refrigerator is not used, keep the container during the process of curing, in a cool well ventilated place. The most convenient place, perhaps, is where the water cooler is usually kept, or in the *banguera*. The meat may be kept at a lower temperature than the surrounding air by wrapping the container with a piece of cloth, burlap or gunny sack, and keeping it moist by frequent sprinkling.

Length of time in the brine. Allow from four to seven days in the brine for every kilogram of meat in one whole piece. For example, a two-kilogram piece of meat should remain in the brine from 10 to 14 days; a five-kilogram piece from 25 to 35 days. At the end of the required time take the meat out, preferably in the evening, and allow it to drain over-night in an open shelter, or above the fireplace or in the smokehouse proper.

If the brine, after the meat is taken out, is clear and fresh and free from mold the meat may be hung up at once to drain. But if the brine is not clear the meat should be rinsed in cool water in which salt has been dissolved.

When the meat cures satisfactorily there is no need of repacking during the process of curing. Sometimes, however, some pieces or a portion of one may not be curing well, and repacking becomes necessary. If about the second or third day after the meat has been packed in the vessel, bubbles come to the surface, the curing is not going on satisfactorily. Press the packed meat with the hand and if a rather disagreeable odor is noticed the meat should be overhauled and examined. In many cases only a piece or a part of a piece is affected, the other pieces may be curing nicely. With as little handling as possible remove or cut out the affected parts and rinse the rest of the meat. Repack in a clean vessel. Either use a freshly prepared brine or boil, strain and cool the same brine before pouring it over the repacked meat.

For the benefit of those who wish to keep a supply of home cured pork throughout the year with little effort and little outlay in equipment for the purpose, the following directions are given. The practice has been tried with success:

Hang up the pork to be cured to cool for a few hours in an airy place. Then prepare the following brine which is sufficient for one kilogram of meat:

- 1 cup (coffee cup) of salt
- $\frac{1}{4}$ cup of sugar
- $\frac{1}{2}$ level teaspoonful of saltpeter
- 4 glasses of drinking water

Trim the meat and place it in a *camao* or in a small earthen pot; place a weight on it and pour over the brine; place the container with meat in a cool place for four days to cure. Then hang the cured meat up over an open fire cooking place to smoke. After two days smoking, the meat is

ready for use. Cure these small amounts, say a kilogram, frequently enough to keep a supply of pork on hand.

Smokehouse. For smoking meat in large quantities a smokehouse should be built. Using salvage lumber, the College constructed a cheap smokehouse which has proved efficient. This smokehouse is octagonal, 1.6 meters from one wall to the opposite one and 2.5 meters high. The only opening in the building is a door .5 meter wide by 1.5 meters high. The construction is such that when the door is closed it admits only air enough to keep the fire smoldering, hence lets out little smoke, practically none from the upper portion where the meat is hung.

Smoking the meat. Early in the morning after taking the meat from the brine, begin to smoke it. For fuel, corn cobs, rice hulls, ipilpil and guava wood may be used. The meat may be smoked continuously, if in a smokehouse, or only at cooking time if the open fire is used. Smoking is continued until the skin or fat surface becomes an amber color. The smoked meat may be used two days after smoking.

The meat should be hung up for smoking not lower than one and one-half meters above the fire in the smokehouse and one meter above an open smoking place like the cooking fire in the ordinary kitchen. If the cooking fire is used the meat must be protected from flies. This can be done by putting the meat inside a box—a kerosene can box will do—and closing the bottom with a piece of wire netting or a piece of *sinamay* mosquito netting.

Under ordinary conditions, the best way to store smoked meat is to hang the pieces in a cool well ventilated place. When a large quantity is cured at a time and is to be kept for some length of time each piece should be placed in a tight bag, which should be tied in such a way as to prevent insects from getting in. The bags should be hung in a convenient proper storage place.

REMARKS AND SUGGESTIONS

Pork, carefully cured, using the brine formula given and under the conditions described in this circular compares favorably with the imported products from the United States or Europe. For frying, without boiling first, the ham, that is thigh and shoulder, is superior to the Chinese ham.

Some people like ham saltier than the recipe given produces. When this is desired increase the amount of salt given in recipe. There is no fear of harm as salt decreases the danger from putrefaction during the curing process.

A comparative test was made at the College of the brine, dry, and the dry-and-brine methods for preserving pork. In all cases, products of high quality, particularly in color, texture and flavor were obtained from the brine cure method, but it was attended with more risk from spoilage than

either of the other two methods. From the standpoint of facility and insurance against spoilage the dry-cure process was found to be the best. Meat cured apparently more rapidly and more completely under this method than in either of the others, but the product was comparatively dry, hard, and not delicately and uniformly flavored. It was, however, far from being as dry, as hard, and as dark in color as the Chinese ham. There was no advantage secured by the use of the dry-and-brine cure method; moreover, it is laborious.

Shrinkage up to the end of the curing process is about 17 per cent for pork cured under refrigeration; 19 per cent under ordinary temperature.

Health of animal and cleanliness in work are the most important factors in butchering and in curing meat. Before putting meat to cure be sure that it is completely free from animal heat.

It costs from three to five centavos for brine ingredients to cure one kilogram of pork. At ₱1.00 a kilogram for pork, plus 4 centavos for brine ingredients, and with 21 per cent shrinkage, .8 kilogram of ham costs ₱1.04, or a kilogram of ham thus made costs ₱1.30 approximately.

MAKING AND PRESERVING SAUSAGE

Sausage originated as a measure of economy with the thrifty farmer's wife in Europe, and possibly in other regions also. When a hog was killed there were always parts and scraps that could not be preserved as pickled or salt pork or as smoked ham and bacon. These were ground up and seasoned and kept in different ways as sausage. The word is derived from a French word meaning sauce, indicating that sausage is highly seasoned. As the making of sausage improved it became a highly esteemed form of meat. Manufacturers learned and commercialized the art; they now turn out products for those who buy cheaper grades and high grade products for those who are willing to pay for extra quality. But sausage still holds its original place of economy in many farm houses in Europe and America. It is also an economy meat with the wife of the laborer and factory worker. She buys meat scraps and very cheap cuts and makes a palatable sausage for her family.

Sausage is made in Filipino homes. The practice, however, is far from common. The kind of sausage that is generally made is poor in nutritive value as it consists largely of fat and is not palatable. Its keeping quality is poor.

At the College, efforts have been made to find by experiment some standard preparations of pork that will stimulate hog production. One object in these efforts is to find some way of utilizing as much as possible of the carcass and thus stop much of the present waste. Another object has been to prevent waste and extravagant use of meat at times of butchering by finding some way of using the surplus. If this could be done, homes

could have a moderate supply of meat all the time, not only the poor but the well-to-do who do not have the advantage of cold storage.

One result of our efforts that we can recommend is the making of sausage out of the surplus meat and scraps. In this circular we give some recipes that have been tried repeatedly with success.

Materials for sausage making:

a. Trimmings, meat scraps.

b. Preservatives and condiments as:

Common salt	Sage	Vinegar
Saltpeter	Nutmeg	Toyo
Black pepper	Cinnamon	Patis
White pepper	Cloves	Lemon juice
Red pepper	Thyme	Molasses
Coriander	Bay leaves	Onion
Marjoram	Allspice	Garlic
Pimenton (red pepper)	Mustard	Sugar
Mace	Paprika	etc.

c. Casings.

Small and large intestines

Cheese cloth

How to make sausage

Cooling the meat. Meat should be cooled under ordinary temperature, or if possible in a refrigerator or cooling room.

Boning and cutting. Cut the meat into small pieces separating the lean from the fat. This is done so as to facilitate the mixing of the two in the proportion called for according to the kind of sausage to be prepared. Discard such parts as are deemed unsuitable for consumption, as bones, cartilage, skin, gristle, clots. Then pass the lean and fat separately through a meat grinder using a coarse plate.

Mixing the meat with ingredients. Put the proportion desired of the lean and of the fat meat in a bowl. Add the proper amounts of the necessary curing agents and spices for seasoning and mix thoroughly with the hands. Then pass the mixture through the grinder using a fine plate.

Preserving. If the sausage is to be preserved for future use, it is stored in a refrigerator, or packed in a can or jar and sterilized, or stuffed into casings. When stuffed into casings it is smoked at once to complete the preservation process. Smoking, of course, imparts a particular flavor to the sausage.

Storage. Sausage that is to be used within a few weeks can be left in bulk in open containers well protected from flies and other insects, stored in a cool well ventilated place or in a refrigerator. When the amount of sausage prepared is considerable, the portion that cannot be disposed of within a few weeks should either be packed in mason jars, sterilized and sealed, or stuffed in casings, and smoked to complete the curing process;

incidentally, smoking produces another variety of sausage from the same mixture. After smoking, the sausage may be put away raw or cooked in a stone crock, *gusi*, or packed in jars, sterilized and sealed.

Sausage recipes. Most of the recipes given in this circular are modification of those given in various publications. (See list under literature cited). Modifications were made to suit Philippine conditions and to meet the particular taste of Filipinos as represented by the members of the Makiling Ladies Club (a local club) who kindly consented to give their judgment on samples of sausages prepared in the course of this study.

Pork sausage

650 grams lean pork	20 grams salt	1 gram sage
350 grams fat	2 grams black pepper	1/2 gram nutmeg

No water should be added if the sausage is to be stored without stuffing into casing. If it is to be stuffed in casing add a little water to facilitate the process of stuffing.

Sausage (Chorizos Spanish style)

	<i>Recipe No. 1</i>	<i>Recipe No. 2</i>
Lean pork	1 kgm.	1/2 kgm.
Beef		1/2 kgm.
Salt	20 grams	20 grams
Pimenton	2 grams	2 grams

Creole sausage

1 kgm. pork trimmings	2 grams cinnamon
15 grams salt	2 grams mace
10 grams pimenton	2 grams nutmeg
2 grams black pepper	

Bockwurst sausage

1 kgm. cured trimmings and tongue	2 grams sage
3-1/2 grams black pepper	2 grams nutmeg
2 grams mace	2 grams pimenton
2 grams cinnamon	

Ham sausage

1 kgm. ham trimmings
2 grams black pepper
1 gram mace

No salt is added to the ham as the meat is already salted by the brine cure. The smoked ham is ground with the condiments, stuffed in casing and smoked as usual.

In all the recipes which call for the use of cured meat, fresh meat may be cured in the brine made as used for curing pork.

<i>Summer sausage</i>		
	<i>Recipe No. 1</i>	<i>Recipe No. 2</i>
Beef trimmings	600 grams	
Pork trimmings	400 grams	1 kgm.
Black pepper	5 grams	2-1/2 grams
Cinnamon	5 grams	2 grams
Nutmeg	2-1/2 grams	1-1/2 grams
Sage	1 gram	1 gram
Pimenton	2 grams	2 grams

The meat, cut in small pieces, is put in brine for 24 hours. It is then ground and mixed with the condiments as described under general procedure and allowed to stand over-night. It is then stuffed into casings, if desired, and smoked under as low temperature as possible.

<i>Blood sausage</i>	
400 grams lean pork	10 grams pimenton
600 grams fat	2-1/2 grams mace
200 grams blood	2-1/2 grams black pepper
20 grams salt	2 grams cinnamon

Add the blood to the lean meat at the same time the seasoning is added. Then add the fat. Stuff in casing and smoke.

<i>Bologna sausage style</i>		
	<i>Recipe No. 1</i>	<i>Recipe No. 2</i>
Beef cured	600 grams	500 grams
Pork	400 grams	500 grams
Salt	20 grams	20 grams
Water	200 grams	200 grams
Black pepper	2-1/2 grams	2-1/2 grams
Mace	1 gram	1 gram
Coriander	1/2 gram	—
Cinnamon	—	1 gram
Sage	—	1 gram
Nutmeg	—	1 gram

Grind the beef and pork, using a coarse plate, then put it in brine for 24 hours. Then pass it through the meat grinder using a fine plate and put in a bowl; add the spices and water. Mix thoroughly with the hands until the whole mass has turned dull in color and become sticky. Stuff into casings and hang up to cool for about half an hour. Then smoke for a few hours. Cook below boiling point until it floats. Then plunge in cold water, remove and smoke for a few hours. To keep this sausage for a long

period of time pack it in glass jars after smoking it raw and sterilize and seal.

Liver sausage

350 grams lean pork	7 grams pimenton
350 grams fat	3-1/2 grams black pepper
300 grams liver	1 gram cinnamon
20 grams salt	1 gram mace

Cook the pork trimmings long enough for the meat to be easily separated from the bones. Grind the meat using a medium plate. To this meat add the raw ground liver and seasoning, mix well, stuff into casing and cook until it floats. Then plunge in cold water, remove and smoke for a few hours.

Chorizo de Extremadura

	<i>Recipe No. 1</i>	<i>Recipe No. 2</i>
Lean pork	400 grams	400 grams
Fat	200 grams	200 grams
Beef	400 grams	400 grams
Salt	150 grams	150 grams
Black pepper	7 grams	7 grams
Onion	7 grams	7 grams
Vinegar	2-1/2 grams	—
Pimenton	—	10 grams

Lean meat sausage

1 kgm. lean pork cured
5 grams lard
1 gram black pepper
1/2 gram mace
1/2 gram pimenton

Country sausage

800 grams lean pork	2-1/2 black pepper
200 grams beef	1 gram cinnamon
20 grams salt	1 gram mace

After grinding and thoroughly mixing with seasoning allow mixture to cool over-night. Then add a little water to facilitate the process of stuffing into casings, smoke in cool temperature if possible.

Canning sausage

Sausage may be canned in bulk without smoking, or in casings after it is thoroughly smoked and dried. Sausage in casings can also be canned with or without lard or vegetable fat.

Put the sausage into the jars cold, filling them without pressing them too closely. Adjust the rubber rings and lids and screw down sufficiently to prevent the water bath from getting into the meat jar but not tight enough to seal. Place the jars in a hot water bath as in the fruit or vegetable

canning practiced in many homes. Heat gradually and keep in the boiling water bath for four hours. Remove the jars and seal at once by screwing the lid down as far as it will go. Leave jars to cool, first turning them upside down so as to detect those that have not been sealed properly. When leaking jars are detected the tops should be screwed tightly at once. It is safer to heat the jars again and then screw tops very tight.

In this connection it may be mentioned that any meat preparation, as boiled pork, cooked pork chops, pork roast, etc., can be canned successfully using the method described above. When the jars are opened several months later the meat is just as good and as nutritious as when freshly cooked. A practical plan is for a few housewives in a neighborhood to buy a steam-pressure cooker. It is too expensive for the average housewife to own alone; and with planning it can serve several. With this cooker the work is easier and success is reasonably sure.

Helpful hints

To prevent or retard the formation of molds. Stuffed sausage should be thoroughly dried in the smoking process. Should sausages mold, they should be hung in the sun to dry and the mold should be rubbed off with a clean cloth. To improve the appearance of the sausages wipe them with a cloth dipped in salted lard.

To keep sausage for a reasonable length of time without its becoming rancid. When stuffing the casing avoid the formation of air pockets. Be sure the casings have no holes in them; they must be protected from ants and other insects which will make holes in them. The pores of the casings should be kept closed by thorough drying, especially in the case of sausages that are to be stored raw. To remove the grease from the outer surface of cooked stuffed sausages that are to be stored and to make them shrink and close the pores immerse them in hot water and then in cold water then hang up to dry. Store the sausage in a cool dark place, in a refrigerator, or in sealed, or air-tight containers. Do not keep them in storage too long. If possible, pack or store the sausage without cutting the links. Use fresh casings. When the casing is made of cloth cover it with a thin coating of paraffin before storing.

To suit individual taste. Any of the seasoning ingredients given in the foregoing sausage recipes may be removed, reduced or increased in amount. Other spices may also be added.

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PYTHIUM ROOT-ROT DISEASE OF CORN IN THE PHILIPPINE ISLANDS¹

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WITH FIVE TEXT FIGURES

The occurrence of *Pythium* root-rot disease of corn (*Zea mays* L.) in the Philippine Islands was reported by the writer in 1930. The disease was subsequently reported by Ocfemia (1931) as one of the economic plant diseases new to the Philippines. In the present paper a more detailed study of the disease is given, including the description, the morphology and taxonomy of the causal fungus, and suggestions for its control.

REVIEW OF LITERATURE

Johan, Holbert, and Dickson (1926) found a species of *Pythium* associated with the root rot and seedling blight of dent corn in Illinois and Wisconsin. These authors consider this species of *Pythium* to be closely related to the form associated with the root rot of sugar cane which was studied by Carpenter (1921). Valeau (1926) described a soil-borne disease of corn, and stated that it is due to a species of *Pythium* apparently also similar to the *Pythium* reported by Carpenter (1921). Branstetter (1927) reports a species of *Pythium* that rots the roots of corn in Missouri and this author believes that the species is similar to the *Pythium* described by Carpenter (1921). Drechsler (1928), however, after a careful morphological study of the species of *Pythium* concerned in the rotting of roots of corn and sugar cane, came to the conclusion that the corn *Pythium* is entirely different from the cane *Pythium* in Hawaii. Weston (1920) while working on downy mildew of corn in the Philippines reported the occurrence of two forms of *Pythium* causing destructive rots of stems, ears, and shanks of corn after it has been seriously attacked by downy mildew. No detailed study, however, has been made on these two forms of *Pythium*, consequently comparison of the root parasitic *Pythium* under consideration with the two forms reported by Weston (1920) cannot be made.

ECONOMIC IMPORTANCE

According to Johan, Holbert, and Dickson (1926), in field inoculation of 18 pedigreed strains of corn in the cool wet spring of 1924, the average

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reduction in stand of the plants was 30 per cent. The maximum reduction in yield of sound corn per plant was 65 per cent in one strain notwithstanding the thinning due to 31 per cent reduction in stand. Actual field observation on the Philippine *Pythium* root-rot disease in heavily infested fields under favorable conditions showed that the reduction in stand of susceptible varieties ranges from 25 to 35 per cent. When an infested soil is planted repeatedly to susceptible varieties the malady becomes a constant menace to the corn crop. According to Salvado (1930) a higher percentage of mortality due to *Pythium* root rot was observed on corn plants in the inbred F_1 than in the F_2 generation planted for the second time. There seems to be a tendency to susceptibility to the disease in inbred plants. The disease was observed on Native Yellow Flint and White Dent corn.

SYMPTOMS OF THE DISEASE

The first visible external symptom of the disease is the pale yellow appearance of the foliage of the plant. In case of serious infection the plants exhibit severe wilting with apparently no sign of previous discoloration. A little later, the affected plants fall over owing to the rapid rotting of the shank just above the surface of the soil. Severe rotting of the shank is brought about by the secondary invasion of a group of saprophytic organisms consisting of bacteria and other fungi. A diseased plant can be pulled up easily only it often breaks at the rotting region of the shank. The tips of the roots are invariably the most seriously affected. The roots die back, and later the entire root stock and a portion of the shank may be involved. The rotting on the shank is indicated by the water-soaked appearance. The rotting portion emits the offensive foul odor characteristic of putrifying organic matter. The rotting may reach a portion about 100 millimeters above the root stock. In the Philippines the disease has never been observed in the seedling stage causing seedling blight as is reported in the United States. Susceptible varieties may be infected from when about 30 centimeters high up to when the plants are approaching maturity.

CAUSAL ORGANISM

Isolation

Corn rootlets collected at various times and bearing moderate infection of the disease, when cut to pieces, teased apart and examined under the microscope invariably showed in the tissue the presence of profuse fungous hyphae and fruiting bodies of a species of *Pythium* (fig. 1.). The causal organism was isolated without difficulty. Newly infected rootlets were cut into convenient sizes; washed from four to six times with sterile distilled water and then placed directly on plain steamed corn meal in petri dishes. From the numerous isolations made at various times there consistently

developed *Pythium* growths. Only a very few cases showed contamination with bacteria, *Fusarium*, and other fungi. Subcultures were easily made from uncontaminated colonies.

CULTURAL CHARACTERS

The fungus was grown on various common laboratory culture media, such as potato-dextrose agar, corn meal agar, oatmeal agar, carrot agar, potato plug, carrot plug, and steamed green bean pods. In general, the fungus showed downy to moderate aërial cottony growth on all media. One of the characteristics of the fungus observed was that, with the exception of culture on corn meal agar, subcultures exhibited a moderate aërial growth on agar media after two or three days. The surface of the agar slant was completely covered with a thick layer of a white mass of mycelium. A few days later, the aërial growth became depressed and moist. On corn

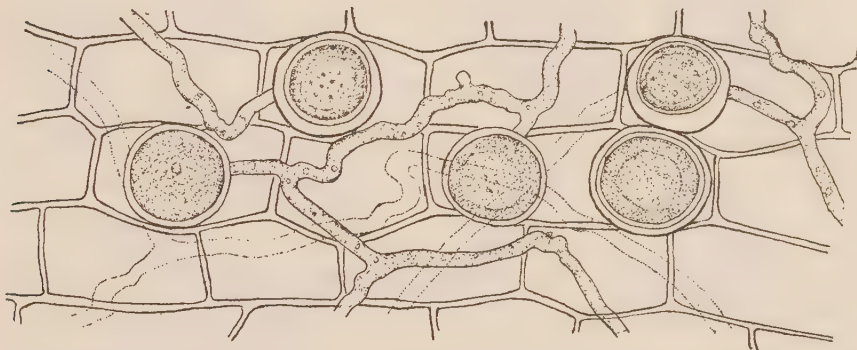


Fig. 1.—Longitudinal section of an infected corn rootlet showing the general distribution of the hyphae, oögonia and oöspores of *Pythium arrhenomanes* Drechsler var. *philippinensis* Roldan in the cells. Camera lucida drawing by the author. $\times 67$.

meal agar the growth was relatively slow, consisting of a thin layer of mycelium on the surface of the slant; the growth presented a downy appearance. On steamed corn meal, potato plug, carrot plug, and green bean pods, the growth consisted of a thick aërial cottony mass. Unless cultures are kept for months the thick cottony growth persists and then it settles back when the substrate is almost exhausted. On all culture media the fungus readily produces fruiting bodies.

MORPHOLOGY

Mycelium

The normal vegetative hyphae are cylindrical, hyaline or granular having fat globules of various forms and sizes, non-septate and irregularly branched. When free from interruption in its development, the mycelium continues its natural fashion of elongation. In the presence of an obstacle

the cell becomes crooked and more or less irregular in shape. The hyphae measure from 1.5 to 4.5 μ broad.

Sporangia

Sporangia are formed aërially in culture. They are produced copiously in the rotting tissues of the host. At first the sporangia are subglobose to irregularly globose. Later, they form into irregular lobed bodies, allantoid, resulting in the formation of compound bodies of fantastic and complex forms (fig. 5 b). They can be readily distinguished from the vegetative hyphae in that they are very much enlarged, and irregular in shape. They have heavier and denser granular contents than the ordinary hyphal strands.

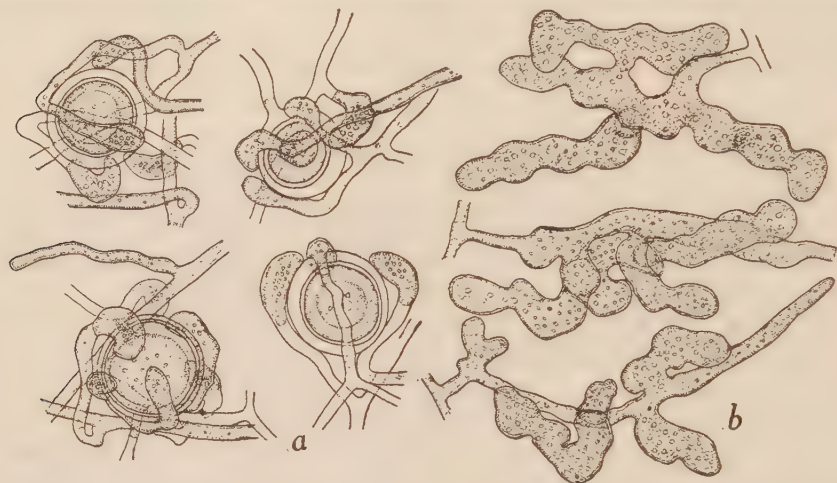


Fig. 5.—Sexual structures of *Pythium arrhenomanes* var. *philippinensis* showing the relation of antheridia and oogonia during the process of fertilization. (b) Labulate sporangia. Camera lucida drawings by the author. $\times 67$.

The sporangia arise from fertile hyphae either terminally or intercalary. The sporangia are connected with the main hyphae by short communicating elements through which materials for the cell contents of the sporangia chamber migrate from the mother hyphae. In water culture, sporangia are produced copiously. In the process of development, they absorb food elements from the fertile cells until the latter are almost completely drained or empty. It has been observed that a sort of cross wall appears between the lobulate sporangia and the communicating elements almost immediately after the sporangia become well differentiated. Although sporangia are abundant both in nature and in cultures, the Philippine *Pythium* has so far not been found to produce zoöspores like other corn *Pythium* reported in other countries. A series of trials was conducted to induce zoöspore production by the sporangia, but it was without success. Pure cultures loaded with sporangia and fresh rootlets of corn impregnated with sporangia were teased apart carefully and placed on sterile cover slips, previously

provided with a drop or two of sterile water. The cover slips were then inverted and fastened with vaseline over sterile hollow slides. The preparations were finally subjected in the ice chamber to varying temperatures ranging from 10 to 20°C. Observations for the momentary production of zoöspores at regular intervals were made, but no zoöspore production was noted during the course of the experiment. The sporangia germinated by the production of germ tubes and behaved like ordinary vegetative cells. Measurements made from cultures on carrot agar showed that the sporangia are 12 μ in diameter at the narrowest region and 18 μ at the broadest.

Oögonia and antheridia

In cultures, oögonia are produced either terminally or intercalary. They are subspherical, smooth, and with dense granular contents. The diameter (on carrot agar) varies from 22 to 39 μ . Antheridia are formed terminally, but occasionally, laterally. They are goose- or crook-necked, arising from vegetative hyphae, apparently not from the same mycelium bearing the oögonia. The antheridia at first appear as terminal swellings, and the contents gradually become dense and in shape goose- or crook-necked as they approach the oögonium. From three to several antheridia may be noted crawling at a time upon the oögonium in the process of fertilization, but three to six may be easily distinguished with the probability of not more than eleven antheridia, including those that are concealed. A basal septum appears at the antheridial body as soon as the antheridium becomes well established in its relation to the oögonium (fig. 5 a). From the apex to the basal septum they measure from 11 to 23 μ and the width in the distal expanded portion is from 7 to 10 μ .

Oöspores

On carrot agar, oöspores are subspherical, yellowish brown, with smooth edge, and sometimes they almost completely fill the oögonium. A globular smooth body is contained in each oöspore, surrounded by a wall 1.2 to 3.5 μ in thickness. The diameter of the oöspores varies from 21 to 35 μ and the diameter of the globular bodies in the oöspores from 13 to 31 μ .

EVIDENCE OF PATHOGENICITY

Controlled inoculation tests of corn were conducted. For this purpose, Calauan Yellow Flint and White Dent corn varieties were used. The corn seeds were disinfected with 1:1000 mercuric bichloride solution and washed three times with sterile water. Pots about 20 cm. in diameter and containing ordinary garden soil were autoclaved at 15- and 20-lb. pressure for one hour. After cooling, a portion of the soil about five centimeters deep, was removed from the top and the inoculum which consisted of a mixture of *Pythium* cultures on steamed corn meal and sterile soil in the

proportion of 1:1 was placed in the pots and then covered with the sterile soil that was removed. The disinfected corn seeds were sown about two or three centimeters deep. For the checks the same procedure was followed but instead of using mixture of soil and cultures of *Pythium* a mixture of soil and plain steamed corn meal was used. This method, with slight modification, was patterned after Edgerton, Tims, and Mills (1929). Two sets of experiments, each consisting of six replications, were made. Each set was performed at different times. In all tests the results were consistent. Slow and rather stunted growth accompanied by the prevalence of pale



Fig. 2.—(a) Check. (b) Inoculated. Note the marked stunted growth of the corn seedlings grown in the inoculated soil.

yellow color of the foliage, but without production of blight on seedlings, was observed on the inoculated seedlings grown in pots, while seedlings in the checks were invariably normal and grew much faster than those in the inoculated pots (fig. 2 a). Seedlings in the inoculated pots as well as those of the checks were pulled up two weeks after inoculation and the condition of their root systems compared. Seedlings from the inoculated pots had very poor root systems, some possessed only one or two rootlets, and in some cases the roots failed to develop at all because the roots rotted as soon as they came in contact with the *Pythium* infected soil (fig. 3 b). The fungus was recovered in pure culture after reisolations were made from diseased rootlets.

Following the above method of inoculation, cross inoculations were made on rice, cowpeas, mungo, tobacco, sugar cane, papaya and ginger. The results obtained showed that the fungus is capable of producing serious root rot on sugar cane (fig. 4 b), very slight attack on rice, very little or no effect on tobacco, papaya, and ginger, and practically no effect on cowpeas and mungo.

PATHOLOGICAL ANATOMY

The method of penetration by the fungus was not investigated. The fungus, however, after entering and establishing parasitic relations with the hosts may be found both inter- and intra-cellularly. In the incipient

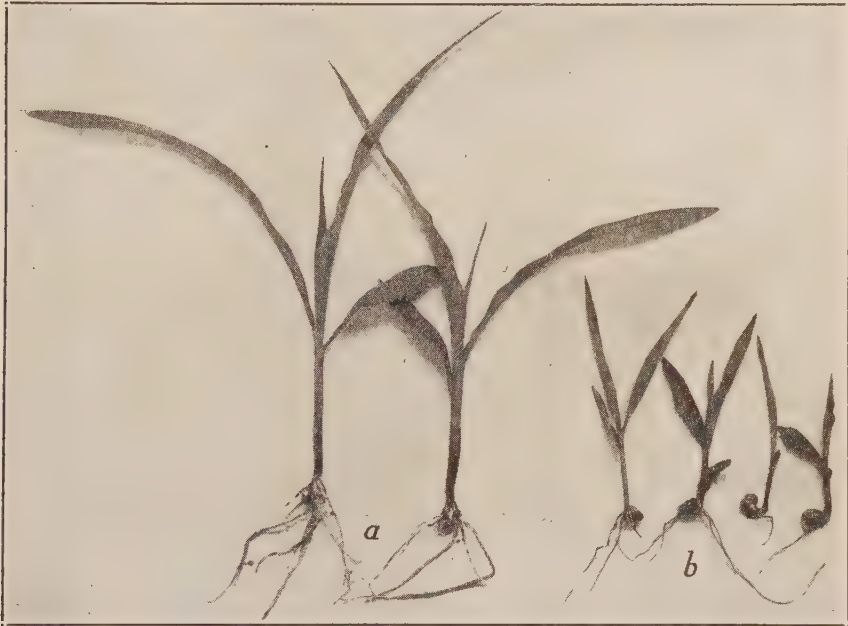


Fig. 3.—Corn seedlings showing the condition of the root systems in (a) control and in (b) inoculated seedlings.

stages of infection the fungus mycelium is intercellular but in advanced stages it is intracellular. The fact that infected roots become soft and flaccid, suggests that a certain enzymic substance is secreted to make the host tissue soft and readily penetrable to hyphae. The fungus does not only cause rotting of the cortex but it also penetrates the central cylinder or the stele. For this reason, *Pythium* infested roots are invariably soft and flaccid.

TAXONOMY

The morphological characters of the fungus under discussion show without doubt that it belongs to the family *Pythiaceae*. For the taxonomic

consideration of the fungus the system most recently adopted by Fitzpatrick (1930) was consulted. According to this system the Philippine corn root parasite belongs to the genus *Pythium*, subgenus *Sphaerosporangium*. Following the proposed system of Sideris (1929, 1930) for treating the family *Pythiaceae*, the Philippine corn *Pythium* would be in the genus



Fig. 4.—Showing the effect of *Pythium arrhenomanes* var. *philippinensis* on the roots of sugar cane. (a) Control. (b) Inoculated.

Nematosporangium. Compared with other pythiaceous organisms which have been described recently as causing root rot of various crops, such as *Pythium aphanidermatum* (Eds.) Fitz. (1923) = (*Rheosporangium aphanidermatum* Edson, (1915), *Pythium butleri* Sub. (1919), and *Pythium arrhenomanes* Drechsler (1928) the Philippine corn *Pythium* is morphologically

more closely related to Drechsler's *Pythium arrhenomanes* than to any of the other species. In some respects, however, Drechsler's *Pythium* differs from the writer's *Pythium* not only morphologically but in their relationship to the host. With respect to the morphological differences, the writer noted that Drechsler's *Pythium* and the writer's *Pythium* differ to some degree in (1) size of their vegetative hyphae, (2) size of the fruiting bodies, and (3) in the sexual reproductive structures. These differences, however, may not be sufficient to consider the two fungi as belonging to different species. The difference in the number of antheridial bodies adhering to the oögonia in the process of fertilization is so obvious that the two fungi could hardly be considered exactly the same. In the Philippine *Pythium*, although several antheridia are produced, the number is relatively small. In the writer's *Pythium* there are only from three to six antheridia that are visible at a time, as compared with Drechsler's *P. arrhenomanes* which has from 15 to 20 as the visible number. The sporangia of the Philippine *Pythium* do not germinate by the production of swarm-spores, a characteristic which is common in some species of *Pythium*. The writer's attempts to induce zoöspore germination of the sporangia of the Philippine *Pythium* were unsuccessful. The non-zoöspore production of the Philippine *Pythium* makes it similar to the *Pythium* reported by Edgerton, Tims, and Mills (1929). According to these authors, however, the *Pythium* they describe does not produce fruiting bodies readily in culture so that it is, without doubt, different from the Philippine corn *Pythium*. The writer's *Pythium* produces readily abundant fruiting bodies on culture media. In regard to the relation of the parasite to corn, another difference occurs between *P. arrhenomanes* and the Philippine *Pythium*. The Philippine *Pythium* does not cause seedling blight of corn, while *Pythium arrhenomanes* causes both seedling blight and root rot. Considering the differences and the points of similarity between *Pythium arrhenomanes* and the Philippine corn root rot *Pythium* the writer believes that it is the same species as *P. arrhenomanes* Drechsler. Since it differs slightly in some important characters the writer considers the Philippine fungus as a variety and proposes the combination *Pythium arrhenomanes* var. *philippinensis* Roldan n. var. for the fungus. Table 1 shows a comparison of the morphological characters of the Philippine *Pythium* with other species of *Pythium* described.

The morphological differences between the Philippine *Pythium* and *P. arrhenomanes* Drechsler are as follows: The hyphae of the Philippine *Pythium* are from 1.5 to 4.5 μ broad; labulate sporangia germinate by germ tube, and not by zoöspores, 12 to 15 μ in diameter; antheridia 11 to 23 μ in length, and 7 to 10 μ width; oöspores 21 to 35 μ in diameter, with reserved globules which are 13 to 31 μ in diameter; and walls of oöspores 1.2 to 3.5 μ in thickness. Visible number of antheridia during the process of fertilization ranges from 3 to 6 with probably a total number of not more

than 11 including those that are concealed. In contrast to the above figures a brief morphological description of *P. arrhenomanes* Drechsler is herewith presented. Hyphae 2 to 5 μ broad; labulate sporangia up to 20 μ or more in diameter, producing from 20 to 50 zoöspores; oögonia 24 to 35 μ in diameter, antheridia 12 to 25 μ in length and 6 to 9 μ in width; oöspores 22 to 23 μ in diameter with reserved globules which are 12 to 19 μ in diameter and walls of oöspores 1.2 to 2 μ in thickness. Visible number of antheridia during the process of fertilization 12 to 20 with probable total number of more than 25 including those that are concealed.

TABLE 1

Comparative measurements of vegetative and reproductive structures of different species of Pythium causing root-rot disease of plants

VEGETATIVE AND RE- PRODUCTIVE STRUC- TURES	PYTHIUM AR- RHENOMANES	PYTHIUM AR- RHENOMANES VAR. PHILIP- PINENSIS N. VAR.	PYTHIUM (RHEO- SPORANGIUM APHANIDERMATUM)	PYTHIUM BUTLERI	HAWAIIAN PYTHIUM
Diameter of hyphae.....	2 to 5 μ	1.5 to 4.5 μ	2.8 to 7.3 μ	3 to 8 μ	2.8 to 7 μ
Diameter of sporangia.....	20 μ	12 to 15 μ	—	—	—
Diameter of oögonia.....	24 to 35 μ	22 to 39 μ	22 to 37 μ	18 to 33 μ	24 to 35 μ
Antheridia	12 to 25 μ × 6 to 9 μ	11 to 23 μ × 7 to 10 μ	9 to 11 μ × 10 to 14 μ	—	—
Diameter of oöspores.....	22 to 23 μ	21 to 35 μ	17 to 19 μ	13.5 to 25.5 μ	21 to 28 μ
Diameter of reserved globules.	12 to 19 μ	13 to 31 μ	—	—	—
Thickness of walls of oöspores.....	1.2 to 2 μ	1.2 to 3.5 μ	—	—	—
Number of anthe- ridia	12 to 20 visible, 25 or more prob- able total number	3 to 6 vis- ible, 11 and not more probable total number			

RELATION TO ENVIRONMENT

The disease may be noted in *Pythium* infested fields at any time during the planting season of the corn. However, mild sporadic cases occur

during the dry and hot months of the year. As soon as the rainy season begins, a relative increase in severity of infection takes place; especially towards the latter part of the rainy season; that is, during September, October, and November when the weather is humid and cool. Under these conditions a severe epidemic in susceptible varieties occurs. In some instances during June, July and August, when the rains are exceedingly heavy and when the humidity is relatively high, but the temperature fluctuating, a severe epidemic may break out any time. In places where the topography of the land is such that water is retained keeping the soil extremely moist, making a condition favorable for the severe development of the disease, it is present.

CONTROL MEASURES

Pythium is a soil-inhabiting fungus. In *Pythium* infested fields, corn should not be planted during the period of the year when conditions are most favorable for the development of the disease. Legumes, such as mungo and cowpea, should be planted instead, as these plants are not attacked by the disease. The soil conditions should be improved by aëration and proper draining. Adequate drainage should be maintained in fields which have the tendency to accumulate water, or where the soil tends to become water-logged. If possible, only strains of corn that show resistance to the disease should be planted. In a *Pythium* infested field corn should not be rotated with sorghum, rice, or sugar cane for these plants are known to be affected by a species of *Pythium* (1918, 1919, 1926, 1930). Instead, ginger, tobacco, and papaya, or mungo and cowpea should be used.

SUMMARY

1. This paper describes a *Pythium* root-rot disease of corn in the Philippines. The disease attacks both Native Yellow Flint and White Dent corn.

2. The disease occurs during the planting seasons of corn in *Pythium* infested fields. The degree of severity varies according to the existing environmental conditions. It may cause as much as 35 per cent reduction in the stand of corn.

3. A comparison of the morphological, cultural and biological characters of the Philippine corn *Pythium* with other species of *Pythium* was made and the result shows that it is only slightly different from *Pythium arrhenomanes* Drechsler.

4. Most of the morphological characters of the Philippine *Pythium* resemble closely those of *P. arrhenomanes* Drechsler. It shows, however, some differences, morphologically and biologically. On account of this, the Philippine *Pythium* is considered a variety of *P. arrhenomanes* and for it the name *Pythium arrhenomanes* Drechsler var. *philippinensis* Roldan is proposed.

5. Controlled inoculation experiments reproduced the disease. Controlled cross-inoculation tests showed that the fungus readily attacks the roots of sugar cane, attacks slightly the roots of rice, has very little or no effect on ginger, tobacco, or papaya, and no effect at all on mungo and cowpeas.

6. For the control of the disease it is suggested that unless resistant strains of corn are obtained, infested fields should be planted to ginger, tobacco and papaya or cowpeas or mungo. Sugar cane, rice or sorghum should not be included in rotation with corn. The aëration of the land should be improved and the soil well drained.

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A STUDY OF MARKETING RICE IN NUEVA ECIJA¹

DANIEL F. ASUNCION

WITH ONE TEXT FIGURE AND ONE CHART

It is a matter of common knowledge that in the Philippines the marketing of rice, that is, the services of moving the rice from farmers to consumers is largely in the hands of Chinese merchants. It has become a habit in the Islands to lay the blame on the Chinese rice merchants for all the ills of the rice farmers. The popular cry has been to eliminate the middlemen, especially the Chinese. To any one with the most elementary knowledge of agricultural marketing principles, the fallacy in this popular reasoning and the preposterousness of this popular demand are apparent. The rice merchants perform essential marketing services by moving the rice from farmers to consumers. In this age of specialization, every farmer cannot with efficiency perform individually this task in addition to growing the product. Hence, merchants who are specialists in marketing have come into existence to serve as a link between the farmer and consumer. The question is not one of elimination of merchants, but the reduction of the costs of marketing so as to enable the farmer to receive a larger proportion of what the consumer pays the merchants for the product.

A study of the marketing of rice should be of great importance in determining whether or not the essential marketing services are performed with the minimum of cost. On this point, and on this alone, should judgment be based as to the adequacy and efficiency of Chinese rice merchants.

Coöperative marketing among farmers has been pointed out repeatedly as a means of taking away from the Chinese the marketing of rice and also as a means of reducing marketing costs so the grower would receive better prices. Mears and Tobriner (1926) define coöperative marketing as "the organized sale of farm products on a non-profit basis in the interest of the individual grower." Macklin (1921) in discussing what coöperative marketing can do for farmers, says, "The true coöperative organization seeks to establish and maintain a distributing system to provide adequately and dependably at minimum cost the essential marketing services of which

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Mr. P. N. Mabbun, under whose advisership this work was originally begun, prepared the outline, but thereafter the work was planned and carried under Mr. Velmonte.

the industry and its individual members have constant and vital need." Two fundamental facts must be borne in mind in connection with coöperative marketing. First, coöperative marketing cannot eliminate middlemen, the coöperative unit is in itself a group of middlemen. Experience in the United States and elsewhere has shown that at best, coöperative marketing can be carried on efficiently only to the wholesaling stage in marketing. Second, coöperative marketing is only justified where it can render essential marketing services at costs equal to or lower than those of existing private middlemen, thus enabling the farmers which it aims to benefit to receive among other things a larger proportion of the "consumer's dollar".

No one disputes the fact that, through organization, the farmer's business benefits, hence the insistent demands by the local press and by responsible government officials for coöperative marketing of rice and of other agricultural products.

No detailed and analytical study has been made of methods of marketing of rice in the Philippines, nor of the costs of essential marketing services. The work here reported was an attempt to study in detail these important aspects of the marketing of rice in the province of Nueva Ecija; this province was selected because it produces more rice than any other province in the Islands.

The definite objects of the work were, (a) to study the methods of marketing; and (b) to find the cost of marketing of rice in the province of Nueva Ecija.

The survey was conducted during December, 1929, April and May, 1930, and December, 1930. Surveys were made in the municipalities of Aliaga, Cabanatuan, Cuyapo, Gapan, Guimba, Muñoz, Peñaranda, San Isidro, San Jose, Sto. Domingo, Talavera, and Zaragoza in the province of Nueva Ecija. The data for the survey referred to the 1929-1930 palay crop.

METHODS OF SURVEY

The study of marketing of the rice crop naturally falls into two distinct phases, the marketing of palay, and the marketing of rice.² From the marketing standpoint, rice mills are classified as consumers of palay, and the marketing of rice properly begins when the *consumed* palay leaves the mill as rice ready for the ultimate consumer. The results of this survey are discussed under these two distinct phases and in the order here given.

Personal visits to farmers, merchants, transportation men, and government officials were made by the writer.

With the aid of a set of questionnaires, data were collected from landowners, only, because tenants sell just after harvest only a small amount of

² *Palay* is rice with the hulls on. The word *rice* is applied to the grain from which the hull, germ and bran layer have been removed.

their shares of the rice, or sometimes none at all. This custom will be further explained under "Terms of Sale". A total of 620 landowners were interviewed. So that the work would be as representative of conditions as possible, the number of farmers who were personally interviewed in each municipality was predetermined by taking three per cent of the number of farms for each municipality as reported by the Census of the Philippines for 1918. This basis was deemed necessary to insure for each municipality a proportionate representation in the survey. Under this plan the land owners surveyed were distributed as follows:

Towns	Number of farmers
Aliaga.....	37
Cabanatuan.....	52
Cuyapo.....	112
Gapan.....	20
Guimba.....	86
Muñoz.....	51
Peñaranda.....	43
San Isidro.....	41
San José.....	68
Sto. Domingo.....	32
Talavera.....	33
Zaragoza.....	45
Total.....	620

RESULTS AND DISCUSSION

Marketing

Glossary of trade terms and expressions as used in this article: *Local buyer.* A buyer located in a municipality, who buys, on his own account, palay from growers.

Local rice mill. A mill which depends for supply of palay on crop produced in the municipality where it is located.

Other mills. Mills which are neither local rice mills nor Cabanatuan rice mills.

Cabanatuan rice mills. The mills located in Cabanatuan. They are among the largest mills in the province. Most of them are owned by the Chinese wholesalers of Manila.

Cabanatuan palay merchants. These are merchants in Cabanatuan who buy palay on their own account.

Local representatives of Cabanatuan rice mills. These are salaried representatives of Cabanatuan rice mills in a municipality who buy palay for the Cabanatuan rice mills. These representatives carry on all business in the name of their principals. The money they use for buying palay and to pay all expenses involved, as for materials and equipment, cost of storing and moving palay to Cabanatuan rice mills is all provided by the principals.

Other merchants in Central Luzon. Merchants located in the neighboring provinces who buy palay from growers in Nueva Ecija.

Terms of sale. Two ways of selling palay in Nueva Ecija were observed; namely, cash sale and sale by contract made before harvest. Most of the land owners interviewed sold their rice crops for cash. Because the tenants are in urgent need of money they sell their shares of the rice crop

to their landlords long before the harvest season. They borrow money from their landlords from July to October with the agreement that the loans will be paid in palay. As is to be expected they sell their shares generally at a price lower than the current price after harvest.

Methods of marketing palay

The results of the survey show that in Nueva Ecija palay and rice pass through many different agencies in going from the farmer to the consumer. Figure 1 shows the main channels of distribution for palay and rice. The interlocking circles are intended to show the intimate relationship existing between certain of the agencies interested in the distribution of palay and rice. These outlets are, local buyers, local rice mills, other mills, direct to Cabanatuan rice mills, Cabanatuan palay merchants, local representatives of Cabanatuan rice mills, and other merchants in Central Luzon.

Local buyers. As shown in table 1, of the total palay sold by the farmers interviewed in Nueva Ecija, 20,319.50 cavans or 8.376 per cent passed through the local buyers. Out of the 12 municipalities visited, in only 5 were these middlemen found; namely, Cuyapo, Muñoz, Peñaranda, San Isidro and San Jose. Of the total palay marketed in Cuyapo, 25.03 per cent was bought by the local buyers; in Muñoz, 16.74 per cent; in Peñaranda, 17.73 per cent; in San Isidro, 31.44 per cent; and in San Jose, 14.984 per cent.

Local buyers sold their palay either direct to the local rice mills or to Cabanatuan palay merchants or Cabanatuan rice mills. In the majority of cases they sold to the Cabanatuan rice mills or Cabanatuan palay merchants as they generally paid the highest price.

Local rice mills. The local rice mills were also important outlets for palay in Nueva Ecija. The majority of these rice mills are owned by Chinese. A total of 45,046.00 cavans or 18.568 per cent were sold to local rice mills, showing that it was relatively a more important outlet for palay than the local buyers. Local rice mills were important outlets for palay in Cuyapo, Gapan, Peñaranda, San Jose, and Sto. Domingo. In Cuyapo, 63.10 per cent of the total palay sold by the farmers went to these mills; in Gapan, 100 per cent; in Peñaranda, 75.95 per cent; in San Jose, 68.721 per cent; and in Sto. Domingo, 85.90 per cent. These figures show that where there is a local mill in a municipality it is the largest buyer of palay.

Other mills. Some growers preferred to sell their palay to rice mills located in neighboring municipalities rather than in their own. A total of 18,813.50 cavans or 7.76 per cent passed through this channel. In Peñaranda for example, 6.32 per cent of the palay sold went to mills in Gapan; a municipality, near by.

In one particular instance, in San Isidro, where there is no rice mill, 18,641.00 cavans or 64.74 per cent of the palay sold was bought by rice mills in Gapan.

Direct to Cabanatuan rice mills. From the results of the survey it may be seen that many of the farmers in Nueva Ecija sold their palay

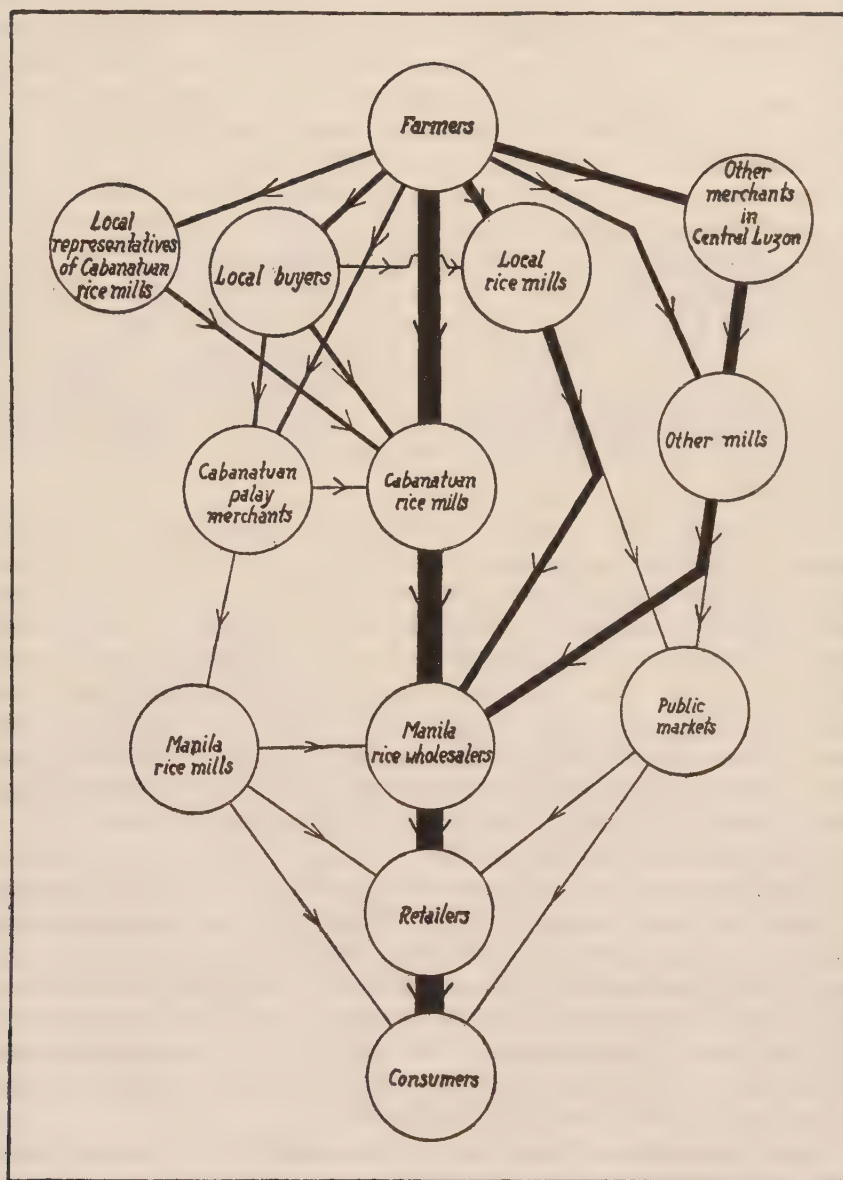


Fig. 1.—Main channels of distribution for palay and rice produced in Nueva Ecija.

direct to the Cabanatuan rice mills. A total of 95,202.45 cavans of palay or 39.24 per cent went direct to these mills.

In towns, as Aliaga, Zaragoza, and Talavera, where there were no local buyers, local rice mills or local representatives of Cabanatuan rice mills, the farmers sold their palay direct to Cabanatuan rice mills. Aliaga sold 63.33 per cent of its total crop direct to the Cabanatuan rice mills; Talavera, 16.349 per cent; and Zaragoza, 54.195 per cent. In some towns, though there were local middlemen, farmers preferred to sell their crops direct to the Cabanatuan rice mills because they usually paid higher prices than the middlemen. Thus, 28.42 per cent of palay sold by farmers of Guimba was sent direct to the Cabanatuan rice mills; by farmers of Muñoz, 58.90 per cent; and by farmers of Sto. Domingo, 14.10 per cent. Table 2 further emphasizes the overwhelming importance of the Cabanatuan rice mills as a direct outlet for palay in Nueva Ecija. These mills and their local representatives bought 105,824.45 cavans or 43.618 per cent of the total direct from the farmers. It may be seen that almost one-half of the palay produced in Nueva Ecija was sold by the growers direct to the Cabanatuan rice mills. As most of the rice mills at Cabanatuan are owned by Chinese middlemen, it follows that the distribution of palay and rice is largely in the hands of the Chinese.

Cabanatuan palay merchants. The Cabanatuan palay merchants handled a relatively small volume of business. Only 3.028 per cent of the total palay marketed passed through their hands. As they had no local representatives to represent them in different towns they depended largely upon the direct delivery sales of the farmers and also of the local buyers. Palay handled by these merchants was sent either to Cabanatuan rice mills or to Manila rice mills. Farmers in the six towns under survey were found to have direct dealings with Cabanatuan palay merchants; Aliaga sold to these middlemen 36.37 per cent of its crop; Cabanatuan, 0.55 per cent; Guimba, 1.48 per cent; San Jose, 3.652 per cent; Talavera, 1.165 per cent; and Zaragoza, 45.805 per cent.

Local representatives of Cabanatuan rice mills. Of the 12 towns surveyed there were only three, Guimba, Muñoz, and San Jose, where representatives of the Cabanatuan rice mills bought palay from growers. Altogether, 4.378 per cent of all palay marketed in Nueva Ecija passed through their hands. Considering the towns separately, it was found that in Guimba 65.57 per cent of the palay sold by the farmers went to these merchants. In Muñoz, only 21.04 per cent of the total palay sold by the farmers went to them, and in San Jose, 12.344 per cent.

Other merchants in Central Luzon. In a number of towns in Nueva Ecija, growers sold their palay to merchants located in the adjoining provinces of Pangasinan and Tarlac. These merchants were both Chinese and Filipinos. As an outlet for palay in Nueva Ecija, these middlemen were relatively important. Altogether, 18.65 per cent of the total palay of Nueva Ecija was bought by these merchants from growers. In Cuyapo

and Guimba which are near the border of these provinces, the farmers of Cuyapo sold 11.87 per cent and of Guimba, 4.53 per cent of their palay to these merchants. Farmers of the towns of Muñoz, San Isidro, and Talavera, disposed of a portion of their crop to these middlemen. Muñoz sold 3.32 per cent to other merchants in Central Luzon; San Isidro, 3.82 per cent; and Talavera, 82.486 per cent. These merchants sold their palay to mills situated in their place of business.

Methods of marketing rice

The marketing of rice properly begins when the palay is hulled and polished in the mills. The present discussion of the marketing of rice is based on rice coming from the Cabanatuan rice mills because the data show that nearly 50 per cent of the total palay sold by the farmers of Nueva Ecija was sold direct to these rice mills. Bearing in mind that the other buyers of palay ultimately sell largely to these mills, (see fig. 1), the central position of the Cabanatuan rice mills in the scheme of marketing palay and rice in Nueva Ecija is apparent. There were eight large rice mills in Cabanatuan, seven of which were owned by the Chinese, and one by Filipinos. The mills operated by the Chinese were owned by large rice wholesalers of Manila who finance a greater part of the marketing of palay and rice from Nueva Ecija. The rice from these mills is distributed throughout the other parts of the Islands. In an analysis of rail shipments of rice from Cabanatuan for a period of one year, from June 1929 to May 1930, it was found that over 40,000,000 kilograms were shipped outward to various points. Of this amount, it was found that 88.79 per cent was consigned to Manila; 8.85 per cent, to points beyond Manila; and 2.33 per cent, to points not passing through Manila. The largest shipments to Manila were made during January, February, March and April. From these figures it is obvious that the discussion of marketing of rice properly begins with milling in Cabanatuan and ends with the shipment to the central consuming market, Manila. It was observed that the rice shipments to Manila by Cabanatuan mills were largely consigned to wholesalers who control the rice mills at Cabanatuan. Information gathered from Manila wholesalers, who were operators of Cabanatuan rice mills, revealed the fact that retailers of Manila as well as those in provinces surrounding Manila and even those in Visayan provinces were served by them.

Means of transportation

One of the most important problems in marketing is the means of transportation. In general, Nueva Ecija palay is hauled in carts or sleds from the fields to the provincial road. Once assembled by the road, the palay is hauled in carts or in trucks to the growers' warehouse where it is stored for some time with the hope of obtaining higher prices. Then from the

warehouse to the palay merchants or rice mills at the railroad station and elsewhere, it is also hauled in carts or trucks. From the mills, the rice is shipped to Manila by railroad.

Cost of marketing

Prices received by the farmers. When the palay is just threshed the farmer's problem is, when to market his crop so as to get the best returns for his labor. It is to be regretted that the Filipino farmers generally pay very little attention to this important problem. In most cases the whole crop is sold immediately after it is threshed. The farmers can not wait for a time when larger returns for their labor could be obtained. Livingston and Seeds (1917) reported that grain as wheat, an important food of the people in United States, is usually marketed immediately after harvest. This is true in newly developed sections of the country where capital is limited, and the production and marketing of grain form a major portion of the farming operation.

Considering the prices received by farmers separately by towns the following facts were found: Most of the sales were made from January to March, months which immediately followed the harvest. Thus nearly one-half of all palay in Aliaga was sold in March when prices were ranging from ₱2.85 to ₱3.00 a cavan. In Cabanatuan a little less than one-fourth of all palay was disposed of during January when prices were ranging from ₱3.10 to ₱3.30 per cavan. But over one-fourth was held until September when contrary to expectation, prices fell to a level ranging from ₱2.50 to ₱2.80 a cavan. In Cuyapo nearly one-half of all palay was disposed of by growers during the first three months after harvest, that is, January to March when prices ranged from ₱2.80 to ₱3.30 per cavan. It was, however, observed that marketing of palay in Cuyapo was more systematic than in Aliaga and Cabanatuan for farmers were able to hold their crops till November. However, the year 1930 was peculiar in that prices of palay which normally rise from January to November fell sharply causing loss to farmers who had held their grain. Gapan farmers paid dearly for holding most of their crop till September when prices dropped to ₱2.50 and to ₱2.60 a cavan.

Farmers in Guimba disposed of three-fourths of their palay crop from December, 1929 to March, 1930 when prices were higher. Muñoz farmers also had disposed of nearly three-fourths of their crop by the end of March when prices ranged from ₱2.60 to ₱3.20 a cavan. Peñaranda farmers disposed of nearly one-half of their crop almost immediately after harvest, that is, during January at prices ranging from ₱2.90 to ₱3.20 per cavan. San Isidro farmers were able to hold their crop till the coming of the next harvest. Normally, they should have been able to reap large rewards, but as prices fell they suffered heavily. Farmers of San Jose disposed of

over one-half of their palay crop from December, 1929 to March, 1930 at prices ranging from ₱2.60 to ₱3.10 a cavan. Farmers of Sto. Domingo sold over one-half of their palay before the end of March at prices ranging from ₱2.65 to ₱3.30 per cavan. In Talavera nearly nine-tenths of the palay crop was disposed of in January and the farmers profited from better prices. In Zaragoza over one-third of the palay crop was sold by the end of March. Farmers who waited till October before selling another one-third of the crop suffered losses owing to a drop in price to a level ranging from ₱2.40 to ₱2.45 a cavan.

Under normal conditions when the price is at its highest peak as is usually the case during September, October, and November of every year, only three of the towns surveyed, Gapan, San Isidro, and Zaragoza would have received the benefit of the price. The largest amount of palay sold by the farmers from these towns was sold in these months. But, unfortunately, in 1930 the prices during these months dropped instead of going higher as was expected, so that sales in January to March were the better.

In computing the marketing cost of palay and rice the price received by farmers was based on the average price of palay delivered to Cabanatuan mills. This is shown in table 2. The importance of Cabanatuan rice mills as the main outlet for palay was established by the fact that 43.618 per cent of the total volume of palay came to these mills direct from farmers. This fact justified the choice of the price paid by Cabanatuan mills as the basic price in computing marketing costs and in determining the margin taken by the middlemen.

The average price paid by Cabanatuan mills was ₱2.76 a cavan for palay. This was considered, for the purposes of the discussion, the price received by farmers of Nueva Ecija.

Marketing costs. (1) Milling cost: Table 3 shows the cost a cavan of milling palay in Nueva Ecija. To arrive at the approximate cost, eight mills were studied. The following items of cost were considered: (1) salaries and wages; (2) materials and supplies; (3) interest on investment; (4) rentals; (5) taxes; (6) insurance; (7) depreciation of buildings, machinery and equipment; (8) maintenance of buildings and equipment; and (9) miscellaneous expenses. Interest on the investment was figured at 10 per cent; rentals were actual payments by mill owners for the use of sites of the mills; depreciation was figured by dividing the purchase value of the equipment by the probable life of usefulness. From the computation of data furnished by these mills, the following average items of cost were obtained: salaries and wages, ₱0.0213; materials and supplies, ₱0.0087; interest on investment, ₱0.0488; rentals, ₱0.005; taxes, ₱0.003; insurance, ₱0.008; depreciation of buildings, machinery and equipment, ₱0.018; maintenance of buildings and equipment, ₱0.0017; and miscellaneous ₱0.0115 or a total average milling cost of ₱0.1271 a cavan of palay.

These figures are to be taken as approximate, for no phase of the investigation was more difficult than the securing of data on milling costs. This situation was expected as the nature of the data desired was confidential and merchants were not readily willing to furnish the figures. It is believed, however, that these figures nearly approach the actual milling cost.

(2). Selling cost: The selling cost included largely sales taxes paid by wholesale rice dealers at the rate of $1\frac{1}{2}$ per cent of the gross sales. Data on these were furnished by operators of Cabanatuan rice mills. It was found that the selling cost averaged ₱0.0503 a cavan of palay.

(3) Transportation cost: According to the traffic manager of the Manila Railroad Company the freight rates for palay and rice per ton by rail from Cabanatuan to Manila, and from Cuyapo to Manila for carload shipments were as follows:

	<i>Cabanatuan to Manila</i>	<i>Cuyapo to Manila</i>
Palay.....	₱3.53 per ton	₱4.02 per ton
Rice.....	4.38 per ton	4.99 per ton

The rates per ton of rice or palay depend upon the distance. According to the traffic manager the distance between Manila and Cabanatuan is 118 kilometers, and from Manila to Cuyapo, 155 kilometers. The Manila Railroad freight schedules classified palay as class "A" and rice under "5th class" when they are shipped in carload lot. The cars they use for loading are as follows:

Car number	Capacity
	<i>kgm.</i>
NBB	29,925—30,780
JB	21,000—21,090
J	10,545—10,830
K	7,125— 7,182

By computation it was found that since a cavan of palay mills into 28 kilograms of rice, the transportation cost for 28 kilograms of rice from Cabanatuan to Manila was ₱0.1226.

(4) Handling cost. Handling cost covers the cost of loading rice in the car in Cabanatuan and unloading same and delivering to a bodega in Manila. It was found that it costs ₱0.0294 per 28 kilograms of rice for loading and unloading from Cabanatuan to Manila.

Summary of marketing costs. Table 4 shows the spread between the farmer's selling price per cavan of palay in Nueva Ecija and the wholesale price of milled rice of this palay in Manila. It further shows the marketing costs of a cavan of palay and of milled rice of this palay.

Summing up all marketing costs, it was found that the total marketing costs of a cavan of palay and the milled rice from this palay from Nueva Ecija to Manila wholesalers was ₱0.3294.

Spread between farmer's selling price in Nueva Ecija and wholesale price in Manila. The spread between the price received by farmers in Nueva Ecija and the wholesalers' price in Manila is shown in table 4 and graphically in chart 1. It was deemed important to determine first, the part of the wholesale price at Manila that was received by the farmer, second, the margin taken by the middlemen, and third, the profit of the middlemen. These data would have been more complete if it had been possible to compile reliable data on retail prices of rice in Manila, as then the price paid by consumers could have been determined. The only data, however, on prices of rice in Manila are wholesale prices compiled and issued by the Bureau

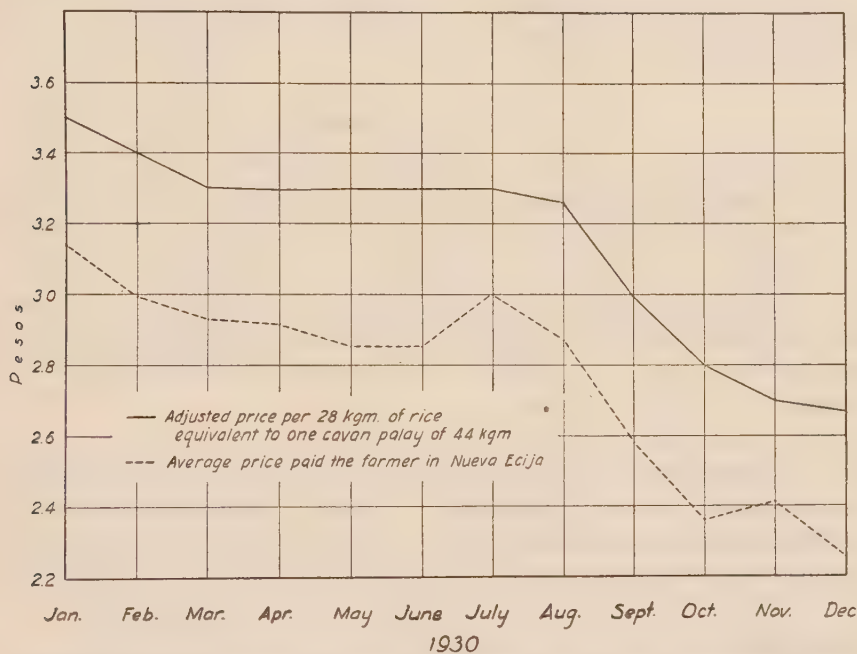


Chart 1.—Showing the spread between the farmer's selling price per cavan of palay in Nueva Ecija and the wholesale price of the milled rice of this palay in Manila.

of Commerce and Industry in the form of daily and weekly market reports. So the figures on wholesale prices at Manila were computed from data obtained from the market reports for the year 1930. It was found that the average price per cavan of 57 kgm. rice was ₱6.46. The adjusted price per 28 kgm. of rice equivalent to one cavan of palay of 44 kgm. was ₱3.172.

It may be seen in table 4 that the farmers of Nueva Ecija received a little over 87 per cent of the wholesale price in Manila, while marketing costs represented over 10 per cent, and profits of miller and wholesalers was approximately 3 per cent. The margin taken by middlemen (except by retailers) was, therefore, 13 per cent.

Chart 1 shows that prices received by farmers in Nueva Ecija, at least those paid by Cabanatuan rice mills, were in close harmony with current wholesale prices in Manila.

It is interesting to compare these figures with those in the marketing of wheat and flour in the United States. In one investigation by the United States Bureau of Labor Statistics, Bulletin No. 130 (1906)⁴ it was shown that the Kansas farmer received about 70 per cent of the wholesale price of flour from his bushel of wheat. Kerr and Weld (1914)⁵ showed that the Kansas farmer received about 76 per cent of the price delivered in Philadelphia.

Thus, Nueva Ecija farmers who marketed their rice direct to Cabanatuan rice mills received a larger portion of the wholesale price of rice than the wheat farmers of Kansas.

SUMMARY AND CONCLUSIONS

1. The results of a survey of 620 land owners in 12 towns in the province of Nueva Ecija are reported in this paper.

2. Two ways of selling palay in Nueva Ecija were observed; namely, cash sale and sale by contract made before harvest.

3. The principal outlets for palay in Nueva Ecija were local buyers, local rice mills, other mills, direct to Cabanatuan rice mills, Cabanatuan palay merchants, local representatives of Cabanatuan rice mills, and other merchants in Central Luzon.

4. Cabanatuan rice mills were the most important direct outlets for palay in Nueva Ecija. These mills bought from the farmers palay representing 43.618 per cent of the total.

5. Cabanatuan occupies a central position in the scheme of marketing palay and rice in Nueva Ecija.

6. Most of the rice in Nueva Ecija was sent to Manila as the principal consuming market.

7. Rice from Cabanatuan mills was sent to Manila wholesalers who were the owners of the mills. Rice from Manila wholesalers was sold to retailers in Manila and in surrounding provinces and in the Visayan Islands.

8. Palay is hauled from the place of production to the mills and merchants in sleds, carts, and trucks, and rice from the mills to the wholesalers by rail.

9. In 1929-1930, the average price received by farmers from the Cabanatuan mills was ₱2.76 per cavan of 44 kilograms.

⁴Cited by James E. Boyle in *Agricultural Economics*. 1924, ix+448p. Philadelphia: J. B. Lippincott Company.

⁵Cited by L. D. H. Weld in *The Marketing of Farm Products*. xiv+483p. New York: The Macmillan Company.

10. When palay was sold by contract before harvest, the price was usually lower than the prevailing price; it was from ₱2.00 to ₱2.50 in 1929-1930.

11. The costs of marketing a cavan of palay or rice milled from this palay from Nueva Ecija to Manila were: milling cost, ₱0.1271; selling cost, ₱0.0503; transportation cost, ₱0.1226; and handling cost, ₱0.0294, or a total of ₱0.3294.

12. The average wholesale price adjusted for rice milled from one cavan of palay at Manila in 1929-1930 was ₱3.1720.

13. The spread between the farmer's selling price per cavan of palay in Nueva Ecija and the wholesale price of milled rice of this palay in Manila was from ₱2.76 to ₱3.172. The farmers, therefore, received approximately 87 per cent of the wholesale price at Manila, the margin of middlemen (excepting retailers) was, therefore, 13 per cent, of which marketing costs was approximately 10 per cent, and profits 3 per cent.

14. The facts seem to prove that the Chinese merchants are performing essential marketing services at a fairly low cost, as rice farmers of Nueva Ecija received relatively a larger share of the wholesale price than the wheat farmers of Kansas.

15. It is, therefore, seen that any other system of marketing, as co-operative marketing among farmers, to justify existence, must be able to render these services at equal or lower costs.

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TABLE 1
Outlets for palay in Nueva Ecija

TOWNS	LOCAL BUYERS		LOCAL RICE MILLS		OTHER MILLS		DIRECT TO CABANATUAN RICE MILLS		CABANATUAN PALAY MERCHANTS		LOCAL REPRESENTATIVES OF CABANATUAN RICE MILLS		OTHER MERCHANTS IN CENTRAL LUZON		TOTAL	
	Per-centage	Cavans	Per-centage	Cavans	Per-centage	Cavans	Per-centage	Cavans	Per-centage	Cavans	Per-centage	Cavans	Per-centage	Cavans	Per-centage	Cavans
Aliaga.....	—	—	—	—	—	—	63.33	3,789.50	36.67	2,194.00	—	—	—	—	100.00	5,983.50
Cabanatuan.....	—	—	—	—	—	—	99.45	66,863.00	.55	370.00	—	—	—	—	100.00	67,233.00
Cuyapo.....	25.03	6,898.00	63.10	17,386.00	—	—	—	—	—	—	—	—	11.87	3,272.00	100.00	27,556.00
Capas.....	—	—	100.00	5,584.50	—	—	—	—	—	—	—	—	—	—	100.00	5,584.50
Guimba.....	—	—	—	—	—	—	28.42	2,817.00	1.48	147.00	65.57	6,500.00	—	—	100.00	9,913.00
Munoz.....	16.74	2,130.50	—	—	—	—	58.90	7,495.00	—	—	21.04	2,677.00	4.53	449.00	100.00	12,725.50
Pearanda.....	17.73	483.50	75.95	2,071.50	6.32	172.50	—	—	—	—	—	—	3.32	423.00	100.00	2,727.50
San Isidro.....	31.44	9,053.50	—	—	64.74	18,641.00	—	—	—	—	—	—	3.82	1,100.00	100.00	28,794.50
San José.....	14.984	1,754.00	68.721	8,044.50	—	—	.299	35.00	3.652	427.50	12.344	1,445.00	—	—	100.00	11,706.00
Sto. Domingo.....	—	—	85.90	11,959.50	—	—	14.10	1,963.05	—	—	—	—	—	—	100.00	13,922.55
Talavera.....	—	—	—	—	—	—	16.349	7,927.90	1.165	565.00	—	—	82.486	40,000.00	100.00	48,492.90
Zaragoza.....	—	—	—	—	—	—	54.195	4,312.00	45.805	3,644.50	—	—	—	—	100.00	7,956.50
Total.....	8.376	20,319.50	18.568	45,046.00	7.760	18,813.50	39.240	95,202.45	3.028	7,348.00	4.378	10,622.00	18.650	45,244.00	100.00	242,595.45

TABLE 2

Showing the relative importance of Cabanatuan rice mills as outlet for palay in Nueva Ecija

MONTHS	DIRECT TO CABANATUAN RICE MILLS	LOCAL REPRESENTATIVES OF CABANATUAN RICE MILLS	TOTAL	SELLING PRICE	
				Typical	Average
<i>1930</i>	<i>cavans</i>	<i>cavans</i>	<i>cavans</i>	<i>pesos</i>	<i>pesos</i>
January.....	24,721.57	2,532.50	27,254.07	3.16	3.14
February.....	5,767.50	2,075.50	7,843.00	2.98	2.99
March.....	15,717.90	2,025.00	17,742.90	2.91	2.93
April.....	3,957.38	1,358.50	5,315.88	2.89	2.91
May.....	4,806.50	425.50	5,232.00	2.84	2.85
June.....	400.00	300.00	700.00	2.85	2.85
July.....	250.00	—	250.00	3.00	3.00
August.....	3,104.10	84.00	3,188.10	2.88	2.87
September....	20,413.50	485.00	20,898.50	2.55	2.58
October.....	9,028.50	—	9,028.50	2.35	2.36
November....	6,327.00	546.00	6,873.00	2.30	2.41
December....	708.50	790.00	1,498.50	2.25	2.25
Total.....	95,202.45	10,622.00	105,824.45	—	—
Percentage....	39.240	4.378	43.618	—	—
Average.....	—	—	—	2.75	2.76

TABLE 3
Showing cost per cavan of milling palay in Nueva Ecija

ITEMS OF COST	RICE MILLS								TOTAL	AVERAGE
	A (600 cavans of palay per day, actual)	B (600 cavans of palay per day, actual)	C (400 cavans of palay per day, actual)	D (400 cavans of palay per day, actual)	E (500 cavans of palay per day, actual)	F (400 cavans of palay per day, actual)	G (400 cavans of palay per day, actual)	H (320 cavans of palay per day, actual)		
	<i>pesos</i>	<i>pesos</i>	<i>pesos</i>	<i>pesos</i>	<i>pesos</i>	<i>pesos</i>	<i>pesos</i>	<i>pesos</i>	<i>pesos</i>	<i>pesos</i>
Salaries and wages.....	.0278	.0123	.0107	.0220	.0345	.0330	.0172	.0134	.1709	.0213625
Materials and supplies.....	.0130	.0074	.0153	.0079	.0084	.0040	.0068	.0068	.0696	.0087000
Interest on investment.....	.0590		.0512	.0318	.0651	—	.0597	.0622	.3906	.0488250
Rentals.....	.0061	.0068	.0083	—	.0064	.0080	.0081	—	.0437	.0054625
Taxes.....	.0020	.0001	.0001	.0011	.0001	.0160	.0002	.0047	.0243	.0030375
Insurance.....	.0260	.0020	.0022	.0027	.0019	.0220	.0022	.0058	.0648	.0081000
Depreciation of buildings, ma- chinery and equipment.....	.0083	.0108	.0109	.0217	.0138	.0550	.0092	.0143	.1470	.0183750
Maintenance of buildings and equipment.....	—	—	—	—	—	.0140	—	—	.0140	.0017500
Miscellaneous.....	—	—	—	—	—	.0920	—	—	.0920	.0115000
Total.....	1422	1010	.9987	.0872	1302	.2470	.1034	.1072	1.0169	.1271125

TABLE 4

Spread between the farmers' selling price per cavan of palay in Nueva Ecija and wholesale price of milled rice of this palay in Manila, 1929-1930

		PERCENTAGE OF WHOLESALE PRICE
Price received by the farmer in Nueva Ecija.....	P2.76	87.01
Marketing costs.....		10.39
Milling cost.....	.1271	
Selling cost.....	.0503	
Transportation cost.....	.1226	
Handling cost.....	.0294	
Profit of miller and wholesaler.....	.0826	2.60
Wholesale price at Manila.....	P3.1720	100.00

NOTE: AN EDUCATIONAL PIONEER¹

A recent issue of the Everett, Washington, U. S. A., *Daily Herald* features an account of the establishment in the Everett Public Library of a special shelf with the complete collection of the writings of Professor Emma S. Yule. The shelf and the books are a gift from Mrs. Bertha Ross Winde, of Everett. Bound with Miss Yule's photograph is a dedicatory tribute by Mrs. Alice Gardner Duryee and an appreciation by Mrs. Margaret Clark Salisbury. These three women are graduates from the Everett High School under Miss Yule, Mrs. Salisbury being the first graduate from this school.

Years ago, Miss Yule, then a young college graduate, went from her native state of Iowa into northwest Washington. Fate placed her in Everett, a new boom town on Puget Sound. As first teacher or Founder of the Everett Schools, as she is now called in this city, it was Miss Yule's job to have the schools keep pace with the town. A high school was opened in a few months. As City Superintendent and by special request principal of the high school, Miss Yule stayed in Everett until the Everett City Schools were one of the "Big Four" in the state.

Possessed of a dynamic, though unobtrusive, personality, a willing and persevering worker even in the face of obstacles that might have discouraged others, ever ready to help her colleagues and her students with a piece of solicited advice here or a word of encouragement there, scrupulously mindful of minute details, obdurate in her stand about what she believes to be right but tactfully considerate of the feelings of her fellow beings, Miss Yule has always been an inspiring and constructive influence wherever she went. She either modifies what she can of her environment for the better, or, failing in this, she pleasantly seeks to adapt herself to her surroundings. Her pioneer spirit took her in her educational work to many lands, including Alaska where, in Juneau, she organized the first government public school in the territory, Japan, and the Philippine Islands. In the Philippines she was first under the Bureau of Education and later under the University of the Philippines, where she has now been connected with the College of Agriculture for about a decade and a half. Significant of the enduring quality of the fruits of Miss Yule's toil is that, after nearly a third of a century of absence, she should be singled out with affectionate remembrance by her former pupils and associates in what is now a bustling American city of 30,000 people, six thousand miles across the Pacific Ocean. It

¹General Contribution from the College of Agriculture No. 312.

is, likewise, a reminder of the stupendous amount of work that still remains to be done at the College of Agriculture that of all the places where she has worked Miss Yule should choose to remain with us the longest. Let us hope that for the rest of her days she may continue to help us extend the paths into vast, untrodden grounds, make us share with her the urge to see the daily tasks accomplished, and give us further chance constantly to open with her such new vistas as alone would satisfy the soul of the true pioneer.

L. B. UICHANCO

Of the Department of Entomology

ABSTRACT¹

The cost of producing panocha in the vicinity of the College of Agriculture. MARCOS A. DE VEGA. (*Thesis presented for graduation, 1931, from the College of Agriculture No. 421; Experiment Station contribution No. 828*).—This investigation was conducted to ascertain the cost of producing panocha in the vicinity of the College of Agriculture, the cost of manufacturing panocha cakes and the cost of selling cane to Calamba Sugar Estate, and then to compare the net income from manufacturing panocha and from selling cane to Calamba Sugar Estate. The study involved the panocha sugar mills of Mr. Emilio Revilleza, Mr. Rufino Castro, and Miss Estebania Banatin; all of these mills are situated in the vicinity of the College of Agriculture at Los Baños, Laguna.

From each mill data on the daily expenses for labor, subsistence of laborers, and use of equipment were recorded. The number of panocha cakes made every day was also recorded.

The data on the selling of cane to Calamba Sugar Estate included the cost of cutting, hauling cane, and loading it in railroad cars at College Station.

Mr. Revilleza's total expense in the manufacture of 110,620 panocha cakes including cost of canes from 99.75 tons was ₱1,016.34. Miss Banatin's total expense in the manufacture of 165,658 panocha cakes from 153.38 tons of canes was ₱1,799.54. Mr. Castro's total expense in the manufacture of 41,522 panocha cakes from 39.13 tons of canes was ₱523.24. In milling College canes in Mr. Revilleza's mill, the total expense for making 27,599 panocha cakes from 14.50 tons of canes was ₱430.03.

The net income from panocha per ton of canes from the different mills was ₱6.45 for Mr. Revilleza's, ₱4.47 for Miss Banatin's, ₱2.51 for Mr. Castro's; and in milling College canes there was a net loss of ₱1.11. The average net income from panocha per ton of canes was ₱3.08.

¹ Abstract prepared as part of the required work in English 3a, College of Agriculture.

The total cost of selling canes to Calamba Sugar Estate was ₱4.50 per ton. The selling price per ton was ₱5.80, giving a net income of ₱1.30.

Comparing the two net incomes there was a difference of ₱1.78 per ton of canes in favor of the manufacture of panocha.

—Abstract by Simon L. Perez.

ABSTRACT¹

A study of the cost of production and distribution of income of maguey in the provinces of Ilocos Norte and Sur. ENRIQUE E. LAZARO. (*Thesis presented for graduation, 1931, from the College of Agriculture No. 422; Experiment Station contribution No. 829*).—This investigation was conducted to determine in the provinces of Ilocos Norte and Ilocos Sur, the following: (1) the cost of producing maguey; (2) marketing methods and costs of maguey; and (3) distribution of income. Data referring to the maguey crop harvested in 1928 were obtained from a total of 202 farmers, 100 of whom were from Ilocos Norte and 102 from Ilocos Sur. In Ilocos Norte, 256.7 hectares of which 72.8 were lowland farms and 183.9 hectares upland were surveyed. In Ilocos Sur, 198.68 hectares of upland farms were surveyed.

The author obtained the following results:

In Ilocos Norte the average cost of production per hectare, excluding marketing costs, was ₱141.14 on lowland farms and ₱166.65 on upland. In Ilocos Sur, the average cost was ₱177.42 on lowland farms and ₱181.32 on upland. In Ilocos Norte, the average cost per hectare, including marketing costs, was ₱144.65 on lowland farms and ₱167.46 on upland. In Ilocos Sur with marketing cost included, it was ₱184.21 on lowland farms and ₱190.28 on upland. The average cost of production per picul of maguey in Ilocos Norte, was ₱7.73 on lowland farms and ₱9.57 on upland. In Ilocos Sur, the average cost of production per picul of maguey, was ₱7.18 on lowland farms and ₱8.25 for upland. With marketing costs included, the average cost per picul of maguey in Ilocos Norte was ₱8.19 on lowland farms and ₱9.75 on upland. In Ilocos Sur, the average cost per picul of maguey, with marketing costs included, was ₱7.34 on lowland farms and ₱8.31 on upland.

Maguey is disposed of either directly to consumer or through middlemen. Some poor farmers barter it for other goods that they need. The farmers usually lack efficiency in the marketing of maguey. The average marketing cost per picul borne by the buyers was ₱2.75 in Ilocos Norte and ₱1.80 in Ilocos Sur.

The average net income per hectare in Ilocos Norte was ₱40.64 on lowland farms and ₱23.85 on upland. The farmers who bore part of the

¹ Abstract prepared as part of the required work in English 3a, College of Agriculture.

marketing cost obtained an average net income per hectare of ₱26.64 on lowland farms and ₱19.03 on upland farms. In Ilocos Sur, the average net income per hectare was ₱65.93 for lowland farms and ₱31.04 for upland. The average net income per hectare of farmers who bore part of the marketing cost was ₱65.27 for lowland farms, and ₱30.40 for upland. Maguey is planted only on land where field crops can not be raised profitably.

—*Abstract by Juan O. Sumagui.*

CURRENT NOTES

At the close of President Roosevelt's second term of office he went abroad. In England he and Lord Grey, then foreign minister, also a lover of birds, went "hiking" to listen to and study the English birds.

The one condition made was—no reporters, no pressmen—the birds object to all but genuine bird lovers: evidently the ex-President fully equalled our Foreign Secretary in this matter. For twenty hours, (not miles) they were lost to the world, and went to hear the birds sing as they must have sung before the Romans came to England. "I found," writes the English Minister, "that my visitor not only had a remarkable and abiding interest in birds, but a wonderful knowledge of them. He knew the birds of this country but not their song. He had one of the most perfectly trained ears for birds' songs that I have ever known. He picked out the blackbird as the best songster. I too have always felt so."

And so these two great men found pleasure and recreation in listening to the songs of birds. No one who has the least love of the country in his tastes will wonder at their choice, blackbirds, thrushes, tites, finches, robins, linnets, are all there quite near to London and we know at least one man who also spends time watching and listening to them, and that, too, on his own lawn.

—*Tropical Life*, March, 1932.

The organization for an evening course in vocational agriculture should center around the economic needs of the farmers of the section. The subject material should be directly associated with the farms and problems of the farmers in the class in a specific, detailed manner instead of being generalized.

—*Agricultural Education*, April, 1932.

Since the discovery that a glass of milk taken before a flight helps to ward off airsickness, air passenger lines have instituted the custom of serving milk to their passengers just before the take-off. Attractive usherettes stand at the door-way of the plane and see that each passenger

is provided with a fiber carton of the beverage, packed in sanitary and convenient form.

—*Popular Science*, May, 1932.

The name leaf-fall has been applied to a disease [of banana] which has occurred during the last year or two in certain plantations in the Tweed Valley. The disease has so far only made its appearance in plantations which have been established on old pasture and sugarcane land.

The disease takes the form of a premature withering and dying of the leaves in acropetal succession, i. e., from the base of the plant upwards. The condition is confined almost entirely to relatively mature plants in affected stools, and is most pronounced in plants which have grown a bunch. Young plants are apparently not affected to any great extent.

—*The Agricultural Gazette of New South Wales*, April, 1932.

The following is recommended as a cheap and efficient substitute for "Flit." Mix 3 pints kerosene; 1 pint petrol; 3 oz. Methyl salicylate and 2 oz. formalin.

—*The Planter*, April, 1932.

During recent years a disease that has so far not been reported upon in the areca or any other palm anywhere has been making its appearance in the rainy districts or the *Malnad* of Mysore and in the adjoining portions of North and South Kanara. Heretofore the only serious disease of the areca palm in these parts has been the *Koleroga* of the nuts caused by *Phytophthora arecae*, but for the last six years a rather serious disease involving the splitting of the trunk from the top portions has been noticed, and it threatens to ruin the arecanut industry. The earliest symptom of the disease is the formation of a longitudinal crack on one face of the trunk, usually that towards the west or south-west. The exposed portions of the trunk in this crack are of a black colour apparently consisting of the protective fibro-vascular bundles covering up the open longitudinal wound. The wound begins about three or four feet below the lowest bunch and may extend twenty or twenty-five feet downwards. In bad cases almost the whole trunk may be involved. The wound does not extend very far laterally nor is it usually very deep. The tissues attacked may be from a half to one inch in thickness. Ultimately a greater amount of the tissues becomes involved. . .

—*The Journal of the Mysore Agricultural & Experimental Union*, No. 3, 1930.

During the month [April] many of the [school] gardens were re-opened after the holidays. Attention was given to improving the layout, cultivation, manuring and replanting of beds. Fences were repaired in some cases. Planting material was supplied to a number of gardens. During visits, notes were made of schools where the supply of tools was inadequate, where supplies of the seeds of common vegetables were deficient and of various matters that required attention. In Johore, sites have been selected for sixteen school gardens, to fifteen of which tools have been supplied and printed instructions on the layout and care of gardens. In these fifteen gardens the layout of beds and paths has been pegged out and their preparation is in progress; the work of felling and removing trees and stumps, where necessary, has been commenced on contract. Considerable enthusiasm is being displayed in the establishment of these new gardens.

—*The Malayan Agricultural Journal*, April, 1932.

COLLEGE AND ALUMNI NOTES

Dr. Richard Woltereck, professor of zoölogy in the University of Leipzig and director of the Biological Station at Seon, Bavaria, was the guest of honor at the seventy-second meeting of the Los Baños Biological Club on May 27, 1932. After his introduction by Dr. Deogracias V. Villadolid, assistant professor of agricultural zoölogy of this College, Doctor Woltereck read a paper on "Differentiation of animal species and races in islands and lakes," in which he discussed the peculiarities of distribution of forms of life in the thirty-seven lakes in Luzon and the southern islands he had had a chance to study during his four months in the Philippines, their probable bearing on geological history, and the rich opportunities which await the investigator along these lines in this country. Incidentally, he regretfully called attention to the fact that the Philippines have been unjustly overlooked, especially by European workers, because of lack of literature on this region extant in European scientific centers.

The officers of the Los Baños Biological Club for 1932-1933 are:

Dr. F. M. Fronda *President*

Professor A. de Mesa *Secretary*

Doctor Fronda is Assistant Professor of Poultry Husbandry and Secretary of the College of Agriculture. Professor de Mesa is Assistant Professor of Forest Pathology in the School of Forestry.

On June 4, 1932 specimens of quinine, *Cinchona ledgeriana*, *C. hybrida* and *C. succirubra* attacked by a disease which appears to be a stem canker were submitted to the Department of Plant Pathology by Professor Ale-

jandro de Mesa of the School of Forestry. The specimens consisted of seedlings from nursery rows and larger plants with diameters at the base of about seven or nine centimeters from the plantation of the Bureau of Forestry at Bukidnon, Mindanao. The specimens were sent to the Division of Forest Investigations of the Bureau of Forestry at Los Baños. G. O. Ocfemia is working on the disease to determine its nature and cause and how the malady may be prevented.

This is the second disease of quinine submitted to the Department of Plant Pathology for study. The first one was seedling blight which broke out in the young seedlings in the Department of Agronomy of the College of Agriculture in February, 1932. The quinine seedlings are said to have come from the Bureau of Forestry and they represent the three species named above. Isolations from the blighted seedlings gave a *Gloeosporium* and a *Fusarium*. The relation of these organisms to the seedling blight will be studied as soon as healthy seedlings are secured.

A book, *The Properties of Sugar Cane Soils of Java*, a translation of *Die Eigenschappen van de Suikerriet gronden op Java* by C. H. van Harreveld-Lako has recently appeared. The translation is by Dr. Robert L. Pendleton, Head of Department of Soils. The Sugar News Press, Manila, is the publisher. The author, Mrs. van Harreveld-Lako, writes with authority for she was for many years the chemist at the Sugar Experiment Station, Pasoeroean, Java; her husband was director of the Station.

F. M. Sacay, B. Agr. '25, B. S. Agri. '26, Ph. D. '31 Cornell University, was recently elected as member of the Cornell Chapter of the Society of Sigma Xi.

Dr. Antonio I. de Leon, Ph. D. 1930, University of Minnesota, newly appointed Associate Professor of Agriculture Chemistry reported for duty May 28, 1932. Doctor de Leon has been connected with the University since 1920 as a member of the Department of Chemistry in the College of Liberal Arts.

Dr. Valente Villegas, Dr. F. M. Fronda and Mr. Alejo T. Taleon, all of the Department of Animal Husbandry went to Mexico, Pampanga, on May 14, 1932. Doctor Villegas was interested in a grade Arabian stallion owned by Mr. Carlos Sandico, a sugar planter of Mexico and an "extension alumnus" of this College, Class of 1931. Doctor Fronda was invited to look over Mr. Sandico's rapidly growing poultry project in which the stock for the most part is Los Baños Cantonese chickens. Mr. Sandico is considering the expansion of his project and requested Doctor

Frona to help him plan the layout of the farm. The farm was started only last September and has now approximately 2,000 chickens.

The summer class on the Economic Study of Fishes, under Dr. Deogracias Villadolid and Mr. Andres Mane of the Zoölogy Division of the Department of Entomology, went on an educational trip to the Bicol provinces from April 25 to May 2. They visited the fresh-water bodies, lakes Buhi, Bato, and Baao; the salt-water bodies, Albay and Tabaco bays, and San Miguel and Ragay gulfs. A general study of fishes, planktons, and fishing operations was made. Information regarding the condition of fisheries, methods of catching fish, disposal of fish, was gathered and specimens for laboratory studies were collected.

A large group of poultry raisers completed the extension course in the College of Agriculture on May 21, 1932. Sixty-two students, twelve of whom were women, enrolled in the eighth extension class in poultry raising on April 11, 1932. Of these, fifty-nine satisfactorily completed the requirements of the course and were awarded certificates on May 21, 1932. Dr. F. M. Frona, Assistant Professor of Poultry Husbandry, aided by Mr. Engracio Basio, assistant in animal husbandry, conducted the class.

During the summer recess, two tanks with a total capacity of 3,000 cu. ft. and four generators were installed in the College gas plant under the supervision of the Department of Agricultural Chemistry. The tanks and generators were formerly in use in the Bureau of Science, Manila.

In the evening of June 1 with a fitting program, the Social Center was inaugurated. The Social Center, a part of the work of the United Evangelical Church at the College, is a building for recreation purposes. There is a large room equipped for various games as pingpong and quoits. There is also athletic equipment as punching bag, boxing gloves, etc. The auditorium has a seating capacity of 600. The stage, large enough for all amateur performances, is very well planned. Both stage and auditorium are equipped for excellent lighting effects. The auditorium can be converted into a basket ball court or place for student or faculty social gatherings. Here, also, is a library and reading room with periodicals and newspapers.

California redwood because of its resistance to anay was used in construction of the building. This lumber was a gift from the Hammond and Little River Redwood Company, California. The money for the erection of the building was furnished by friends of the work in America.

To Rev. Hugh Bousman is due all the credit for this artistic practical building and what it will contribute to the College community. He conceived the idea of the building and through his untiring efforts he brought to fulfillment his conception.

Mr. Mateo D. Jimenez, B. Agr. '26, B. S. A. '28, was a Campus visitor on May 30, 1932. He came to consult Dr. F. M. Fronda and ask for suggestions on the development of the poultry project at Odiongan Rural High School, Romblon, of which project Mr. Jimenez is in charge. Incidentally, Mr. Jimenez bought some Cantonese eggs from the College so as to introduce this breed in Romblon.

Mr. Constancio Medrana, B. Agr. '27, is back in College and is registered in the Supplementary Curriculum. He was granted one year of leave by the Bureau of Education under which he has been working as a teacher in Echague Rural High School, Isabela.

Enrollment in College of Agriculture as of June 13, 1932.

By classes:

Freshmen.....	158
Sophomores.....	102
Juniors.....	145
Seniors.....	186
Special Students.....	5
Special Graduates.....	7
Total.....	603

Number of Women.....	14
Number of New Students.....	150

The enrollment of the U. P. Rural High School is 175. Twenty-one of this number are girls. Forty students are the senior class.

Recent advices report that Mr. Silverio M. Cendaña, instructor in entomology, has just completed his work for the M. S. degree in the University of California. In a letter to Doctor Uichanco, his major professor remarks: "Of all the students whom we have had from the Philippines, Mr. Cendaña is by far the best. . . . I think you are very fortunate in having a man of this caliber in the department here."

Mr. Getulio Guanzon, B. S. Agr. (Certificate in Sugar Technology '25) U. P. Fellow in the University of Minnesota, passed his preliminary examination for Ph. D. March 8, 1932. He expects to receive the degree some time next November.

Recently, Professor Yule received a letter from Mr. E. J. Tavanlar, B. Agr. '26. Mr. Tavanlar is at present employed as an engineer in the Associated Gas and Electric System with headquarters at Rochester, New York. In 1930, Mr. Tavanlar received the degree of B. S. from Sheffield Scientific School of Yale University. He was appointed assistant Instructor in Mechanical Engineering in Sheffield which position he held for two years, meanwhile carrying advanced work. In June, 1932 he was granted the degree M. S. in M. E. He was a candidate for Guggenheim Fellowship in Germany but was disqualified as he was under age. Among his questions about the College is:

"Isn't there any paper or some publication which serves to inform far away alumni of the happenings in the old school?" He also asked as to the functioning and success of the Baker Memorial Fund. Mr. Tavanlar was a generous contributor to this fund.

Mr. Loreto V. Valera, B. S. Agr. '32 (Certificate in Sugar Technology) was a recent Campus visitor. Mr. Valera is employed in the Laboratory in Central Azucarera, La Carlota, Occidental Negros.

Mr. Primo R. Carreon, B. Agr. '25; B. S. Agr. '27, at present manager of the Pampanga Sugar Mills Planters' Association, and Mr. Aguedo Torres, former Far East Olympic hop-skip-and-jump star, were Campus visitors on May 11. Mr. Carreon conferred with members of the Agronomy Department staff on crops suitable for crop diversification in Del Carmen, Pampanga, his district.

R
BIOLOGY OF THE PINK MEALY BUG OF SUGAR CANE,
TRIONYMUS SACCHARI (COCKERELL), IN THE
PHILIPPINES¹

LEOPOLDO B. UICHANCO

AND

FAUSTO E. VILLANUEVA

Of the Department of Entomology

EIGHT PLATES AND FOURTEEN CHARTS

INTRODUCTION

Since the rôle of sucking insects as specific vectors of certain viruses and other pathogenes in plants was definitely established in various countries, pests of this kind have begun to assume increasing importance as an economic problem. Sugar cane, which vies with rice as the premier crop of the Philippines, is affected by a large number of species of sucking insects, some of which are suspiciously associated with certain sugar-cane diseases. One of the most common of these sucking insects is the pink mealy bug, *Trionymus sacchari* (Cockerell), which is of wide distribution in the Archipelago and is found in all months of the year. The presence of this pest in large numbers on a sugar-cane plant is of itself obviously harmful; it visibly results in impaired growth of the host as a direct effect of reduced or altered nourishment; and, from an economic standpoint, the resulting loss in sugar is probably much more than is generally appreciated. A greater evil is in store if *Trionymus sacchari* eventually turns out to be a real transmitter of some of our prevalent sugar-cane diseases. Adequate proofs to this effect still remain to be found; but circumstantial evidence has been gathered during the course of the present work, that at least two pathogenic fungous species appear in many cases in laboratory cultures on parts of the plant where the mealy bugs aggregate. Similar disquieting indications have been reported elsewhere, as, for instance, by Smyth (1919), who mentioned the mealy bug as apparently capable of transmitting a mottling disease in Cuba, and by Bruner (1922), who claims that this pest is a possible carrier of mosaic.

The literature on *Trionymus sacchari* from different parts of the world is quite extensive. The articles, however, are either taxonomic in nature or fragmentary field notes and discussions of control measures. So far as

¹Experiment Station contribution No. 830. Received for publication June 9, 1932.

the authors are aware, outside of the work of Swezey (1913) in Hawaii, but little attempt at a detailed biological study of the pest has as yet been made.

In the Philippines, this species was first authentically recorded by Morrison (1920). Williams (1922), Uichanco (1928), Goseco (1932); a few other workers have contributed brief notes.

Objects of the present work

The work had for its principal objects: (a) a study of the life history, reproduction, feeding habits, host relationship, methods of protection and dispersal of the pest, and other features connected with the insect's power of overcoming environmental resistance and insuring abundance; (b) natural enemies, weather factors, resistant sugar-cane varieties, and other agencies that tend to limit the increase of the pest; and (c) field-control measures.

Time and place

Life history and other detailed work were conducted mainly in the entomological laboratory and on the experiment station farms of the College of Agriculture, University of the Philippines, for two and one-half years, from April, 1929, to October, 1931. Supplementary field data, gathered mainly by the senior author and his assistants since 1927, from the fields of the Calamba Sugar Estate, Canlubang, Laguna Province, and from various fields in Negros are also utilized in part in the present paper.

MATERIALS AND METHODS

Insectary methods

The cultures were of two kinds: mass cultures and individual cultures. The mass cultures were used chiefly for securing specimens of the mealy bug for preservation and for rearing out parasites and predators. The individual cultures were for more accurate determination of the different instars, reproduction, and other records which could not be conveniently secured from mass cultures.

Considerable difficulty was experienced in keeping the individual cultures in the laboratory. At first it was thought that the nymphal instars could be reared in small, cotton-plugged shell vials, containing sections of sugar cane with skin intact on one side, but after repeated trials the method finally had to be abandoned, because the insects died. Potted small cane plants were also tried, but the restless young nymphs were invariably lost or were stolen by ants and could not be located the day after they were transferred into the enclosures between the leaf sheaths and the stem. The procedure soon narrowed down to using cut pieces of stems, enclosed in breeding jars. Pieces containing two or three internodes and of lengths suitable to be confined conveniently were wiped dry with a piece of cloth. The leaf sheaths were removed by cutting, leaving only short stubs where

they joined the stem, to serve as hiding places for the mealy bugs. The newly born nymphs were then transferred by means of a fine camel's-hair brush into these prepared cane points, one into each leaf-sheath inclosure. Numbers for identification of the cultures were written with India ink on the leaf sheaths. It was found during the course of the present work that the cut canes kept fresh long enough to enable the complete life cycle to be carried through.

Field work

Periodical field trips were made for collection of material for insectary experiments, and determination of alternative hosts, susceptibility of different sugar-cane varieties, seasonal abundance or scarcity, natural enemies, and insect protectors.

Acknowledgments

The writers gratefully acknowledge useful assistance rendered by the following: Mr. Catalino T. Buligan, formerly assistant in pest control of the Philippine Sugar Association and the Calamba Sugar Estate, for helping gather the data on varietal resistance of canes and seasonal distribution in Canlubang; the Calamba Sugar Estate for field facilities and for weather records at Canlubang; the Department of Plant Physiology, College of Agriculture, for weather records of the College Campus; to Dr. Gerardo O. Ocfemia and Mr. Emiliano F. Roldan, of the Department of Plant Pathology, for determinations of fungi; to the specialists in the U. S. National Museum, Washington, and to Dr. J. W. Chapman, of Silliman Institute, Dumaguete, Negros Oriental, for determination of various insects and arachnids; and to Mr. Arsenio Y. Coronel, assistant in entomology, College of Agriculture, for help in the preparation of the illustrations.

RESULTS AND DISCUSSIONS

Nomenclature of the pink mealy bug

The present species was originally described as *Dactylopius sacchari* by Cockerell (1895) from alcoholic specimens collected in Trinidad, West Indies. Green (1908) adopted the same name for specimens of this species collected in India. Fernald (1903), on the other hand, listed it in her *Catalogue* as *Pseudococcus sacchari*, and this name was followed by Morrison (1920) until he issued a later paper in 1925, in which he called attention to the fact that this species belongs to another but closely related genus, *Trionymus*. This last interpretation was accepted by Takahashi (1928) in his paper on Formosan Coccidae.

It is important to note in this connection that on account of a close resemblance between *Trionymus sacchari* and certain related forms, it has been confused in certain countries, especially with *Pseudococcus calceolariae* (Maskell), a species which has, "through misidentifications, been used in

literature to designate several different species of mealy bugs." (Morrison, 1925).

Geographical distribution and host plants

The following is a list of countries in which *Trionymus sacchari* is found. They are grouped, according to the classification of Sclater and Wallace, into their respective biological regions. In considering the various countries, allowance should, of course, be made for any chance misidentification by the different authors from whose published reports the information herein reproduced was gathered. Care was exercised in every case, however, to list only those species that were given as *sacchari* under the genera *Dactylopius*, *Pseudococcus*, and *Trionymus*.

<i>Oriental Region</i>	
<i>Countries</i>	<i>Authorities</i>
Formosa.....	Takahashi (1928) ^c
India (South)	
Bombay.....	Ramakrishna Ayyar (1919) ^b
Poona.....	Ramakrishna Ayyar (1921) ^a
Calcutta.....	(Ramakrishna Ayyar (1921) ^b Husain (1925) ^c)
Madras.....	(Newstead (1917) ^b Ramakrishna Ayyar (1921)
Malay Archipelago.....	Dammerman (1929) ^b
Philippines	(Morrison (1920) ^b Williams (1922) ^b)
Negros and Luzon.....	Uichanco (1928) ^c Pierce (1930) ^c Hadden and Lopez (1931) ^c
Java (Soerabaja).....	Hazelhoff (1929) ^c
<i>Oceanic Islands</i>	
Hawaii.....	(Van Dine (1911) ^b Fullaway (1917 ^b), (1922) ^c Sasseer (1918) ^b Other authors
Mauritius.....	Fernald (1903) ^b
Samoa.....	(Swezey (1924) ^b Lajng (1927) ^c)
<i>Neotropical Region</i>	
Mexico (western).....	(Fernald (1903) ^b Van Zwaluwenburg (1926) ^c)
Peru.....	Walcott (1929)
British Guiana.....	Bodkin (1917, 1919) ^b
Demerara.....	Walcott (1913) ^b
Argentina (Tucuman).....	Box (1928) ^c

^a *Dactylopius sacchari* Ckll.

^b *Pseudococcus sacchari* (Ckll.)

^c *Trionymus sacchari* (Ckll.)

Grenada.....	Anonymous (1919) ^b
Antigua; St. Kitts.....	Ballou (1914) ^c
Trinidad.....	{ Walcott (1913) ^b Fernald (1903) ^b Sasscer (1918) ^b Fernald (1903) ^b Walcott (1913) ^b Anonymous (1917) ^b
Barbados.....	{ Dash (1917) ^b Hutson (1918) ^b Bourne (1920) ^b Sasscer (1920) ^b Smith (1921) ^b Sasscer (1920) ^b Barreto (1921) ^b
Virgin Islands (St. Croix).....	{ Bruner (1922) ^b Myers (1926) ^b Van Dine (1926) ^b
Havana.....	Johnston (1917-1918) ^b
Camaguey.....	Stahl and Scaramuzza (1929) ^b
Jamaica.....	Sasscer (1918) ^b
Kingston.....	Godwey (1922 ^b , 1924 ^c , 1925 ^b)
Porto Rico.....	{ Fernald (1903) ^b Jones (no date) ^a
San Juan.....	Walcott (1922) ^b
Rio Piedras.....	{ Smyth (1919) ^b Walcott (1922) ^b
Santo Domingo (Dominican Republic).....	Russo (1927) ^c

Palaeartic Region

Syria (Palestine).....	Bodenheimer (1924) ^b
Madeira.....	{ Grabham (1924) ^b Swezey (1924) ^b
Egypt (Cairo).....	{ Hall (1922, 1926) ^b Swezey (1925) ^b

Ethiopian Region

South Africa (Natal).....	{ Dodds (1929) ^b Brain (1915) ^b Hancock (1925) ^b
Uganda.....	{ Hargreaves (1926) ^c Sasscer (1920) ^b
Rhodesia.....	Sasscer (1920) ^b

It may be seen from the foregoing distributional records that *Trionymus sacchari* is represented in all the biological regions of the world, except in the Nearctic and the Australian faunae.

The choice of food plants by this insect appears to be limited to a very small group within the family Gramineae. In the Philippines, we examined

^a *Dactylopius sacchari* Ckll.

^b *Pseudococcus sacchari* (Ckll.)

^c *Trionymus sacchari* (Ckll.)

the mealy bugs on many plants, mostly on grasses, and also in sedges and pineapples, but only the following host species were found: *Saccharum officinarum* L., *Saccharum spontaneum* L. subsp. *indicum* Hack., and *Andropogon halepensis* (L.) Brot. All of these species belong to the group Andropogoneae. A species of *Miscanthus*, also one of the Andropogoneae, was reported by Takahashi (1928) as another host of *Trionymus sacchari* in Shinkwa, Formosa. We have not collected this mealy bug on any species of *Miscanthus* in the Philippines, although it is not unlikely that this pest might feed here on this host also. Merrill (1925) lists three species of *Miscanthus* as occurring in the Philippines, one of which is endemic and the other two widely distributed; but the plants are usually found at high altitudes. Ramakrishna Ayyar (1919) reports *Trionymus sacchari* as a pest of rice in India, where it causes a disease called "choorai." In October, 1931, we found this mealy bug severely infesting a variety of upland rice, Inariñgay, at Los Baños, near the College Campus; it attacked the upper portions of the stems and caused stunting of the plants and partial abortion of the panicles (see pl. 2, fig. 2). We are not acquainted with the "choorai" in India and, therefore, cannot tell whether we are dealing with identical symptoms. In most of the other references we examined, *Trionymus sacchari* is mentioned in connection with sugar cane.

Possible geographical origin of Trionymus sacchari, with special reference to the Philippines

Trionymus sacchari may easily be carried over long distances with sugar cane points that are used as propagating material. Living mealy bugs have been found between the leaf sheaths and the stem, even where they are in very uniformly close contact throughout, as in the case of cane tops which are generally used as points in the Philippines. That this insect can endure long periods of untoward conditions is attested both by our breeding experiments where we used non-germinating cut stems and by the fact that we found living adults of *Trionymus sacchari* among the half-dried cane stubble that had been dislodged from the soil in fields one or two months after plowing. Likewise, our surveys in harvested cane fields on the day following the burning of trash showed this mealy bug among the most common insect survivors. Mealy bugs were found still living among the stubble and beneath the leaf sheaths on partially charred pieces of cane stems on the ground. Evidently, the downward deflection of the heat currents from the burning trash did not affect the mealy bug individuals to a fatal degree. The unusual hardiness of this species and the repeated importation into the Philippines since prehistoric times of cane propagating material in the form of vegetative parts have for centuries furnished every facility for the pest's accidental entrance into the Archipelago from outside sources. However, the very wide distribution of *Trionymus sacchari*, doubtless due largely to its being carried to different

parts of the world through introduction of cane points, makes it difficult, if not almost impossible, to determine with any degree of certainty in which countries the pest is autochthonous and in which, introduced.

With the exception of Madeira, Syria, and the larger portions of Egypt, which are situated to the north of the Tropic of Cancer, and Natal and a large part of Argentina, which lie south of the Tropic of Capricorn, the distributional range of *Trionymus sacchari* is limited to the tropical belt, wherein it practically girdles the globe. The occurrence of this species in the Western Hemisphere, where it is confined chiefly to the string of islands in the Caribbean Sea, Western Mexico, and three places in continental South America which are remotely situated one from the other is too ragged to

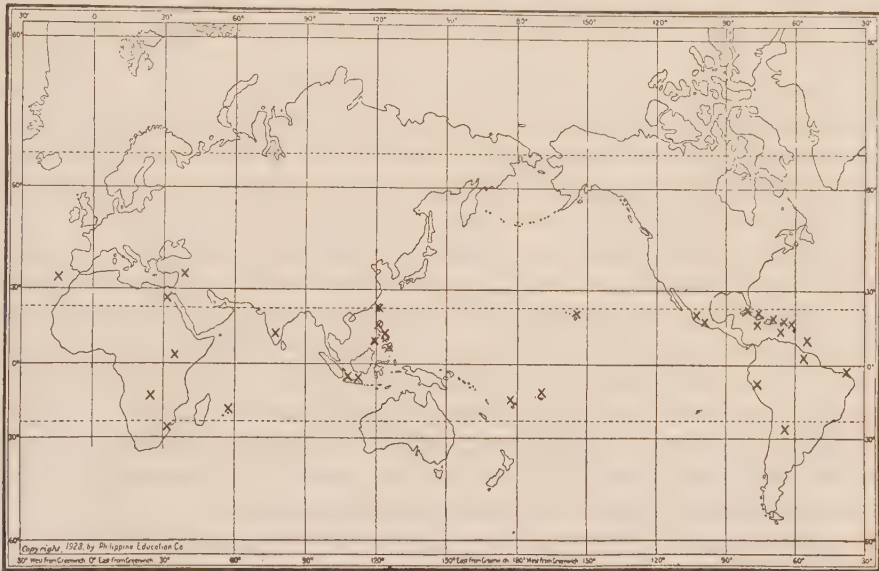


Chart 1.—Geographical distribution of *Trionymus sacchari*.

admit the possibility of *Trionymus sacchari* originating in those places. Moreover, if the insect were autochthonous in that region, it seems unlikely that the pest should become so uniformly a faunal feature in those islands and be apparently absent from Central America, from which the Antilles did not become separated until in relatively recent geological times, that is, within the Pliocene.² It is a well-known fact that especially during the past two or three decades, with the development of the sugar industry, there have been considerable movements of propagating cane points to and from those different islands.

²The geological history of the various localities discussed in the present paper was drawn chiefly from Gadow (1913).

The oceanic islands, Hawaii, Samoa, and Fiji, apparently present relatively little endemism in their respective biotic complexes. Geologically, Hawaii, at least, is presumed to represent tops of what were once submarine mountains, later receiving their terrestrial fauna and flora through immigration after their characteristic land features became established. Samoa and Fiji probably bear close affinities to the Australian biota.

Java is known to be a Pleistocene and the Philippines a Pliocene derelict from continental Asia. Negative evidence, of course, does not prove the absence of *Trionymus sacchari* in any given locality; but so prevalent a pest on an important crop as this mealy bug is certainly could not but have its presence noticed especially in regions as the Federated Malay States, where sugar cane is grown.³ The apparent absence of *Trionymus sacchari* in Southeast Asia, therefore, tends to preclude both the Philippines and Java as the original home of this species. Likewise, southern India, which is also close to land areas with which it bears geologically genetic relationship but in which this species is apparently absent, probably received this pest from elsewhere. This conclusion is further reënforced by the apparent absence of *Trionymus sacchari* in Ceylon, which once formed a continuous land mass with India, probably as late as the mid-Tertiary. The presence of this mealy bug in Mauritius which apparently formed a continuous land connection with India and Madagascar till as late as the early Oligocene can at best merely signify that the pest is also an introduced species in Mauritius, owing to the fact that it seems to be absent in Madagascar. On the authority of Handlirsch (1908, p. 1249), the Coccidae had already shown signs of specialization way back in the Triassic.

Egypt and Syria are close together, but represent a relatively small and isolated land area, surrounded by localities where *Trionymus sacchari* has not been recorded. Madeira is another isolated case.

Indeed, after eliminating the foregoing discrete geographical records, the center of distribution appears to narrow down to the eastern half of the African Region, where the more uniform continuity in distributional range points to the probability of its being the original home of the species. This inference is, however, made with some hesitation, bearing in mind, of course, the still too imperfect knowledge we have of the biota in general of many of the less explored countries. Likewise, an extensive prevalence of a given species in a particular region is just as likely to prove an indication of its being introduced, especially in the case of pests of agricultural crops. The geographical range of the genus *Trionymus* is, likewise, an unsatisfactory criterion, on account of the fact that, judging from its diagnostic characters, it is poorly differentiated from allied genera. Moreover, our knowledge of this group in most parts of the world is still very fragmentary.

³Not in Corbett, G. H., and B. A. R. Gater, 1926. A preliminary list of food-plants of some Malayan insects. Dept. of Agriculture, S.S. and F.M.S., Kuala Lumpur, Bull. 38: vi + 95 p.

Trionymus sacchari is a widespread pest in the Philippines and, hence, its first introduction must be an event of very ancient history. The almost cosmopolitan fungous disease *Aspergillus* (probably *flavus* Link) was probably brought in with the pest during its repeated immigrations. There are at least three species of parasitic Hymenoptera which are known to work on this mealy bug in the Philippines; they may have been introduced with the pest or originally were parasites of our autochthonous insects that found in *Trionymus sacchari* an additional host.

The prehistoric trade routes and the courses of the successive waves of migration of our early Malayan ancestors will conceivably explain how *Trionymus sacchari* first found its way into the Philippines either from its presumably original home in Africa or, what is more likely, indirectly through Southern India and Java.

Morphological considerations

Female. Enumerations of diagnostic characters of *Trionymus sacchari*, based on adult females, have been published by earlier authors, notably by Cockerell (1895), Brain (1915), and Takahashi (1928). In the present paper, no attempt will be made to revise established diagnoses for the species; we shall limit ourselves to points wherein we differ with others either in results or in interpretation and to additional matters which we believe have not hitherto been adequately worked out.

Live notes on adult female. Body uniformly light brownish pink. Antennae light brownish stramineous, darker at apical segment. Legs light brownish stramineous, somewhat darker than antennae, suffusely light yellowish brown at apices of coxae, femora, and tibiae, and the entire tarsi. Body and appendages conspicuously covered with farinose waxy coating throughout, sparsely so at transverse conjunctivae, very much more thickly coated at dorsal than at ventral sclerites, especially at caudal abdominal segments; dense, fluffy accumulation often tipping abdomen, and linearly impressed waxy filaments projecting from around caudal region.

Shape of body elongately hemiellipsoidal; flat ventrally and convex dorsally. Relative lengths of head, thorax, and abdomen in the proportion of 2 : 7 : 6.5. A foveal impression marking insertion of rostrum. Prosternum vaguely subreniform, emarginate anteriorly, rounded posteriorly, length about 0.65 that of head, about 2.7 as wide as long. Mesosternum subquadrate, about 2.5 as long as prosternum, somewhat broader than long, slightly concave at anterior margin and convex at posterior. Metasternum subrectangular, a little less than one-half as long as mesosternum, about thrice as wide as long.

Female nymphs. Coloration of body and appendages, as in adult. Distribution of powdery coating, as in adult, only somewhat thinner. Linearly impressed filaments from around caudal region of abdomen conspicuous.

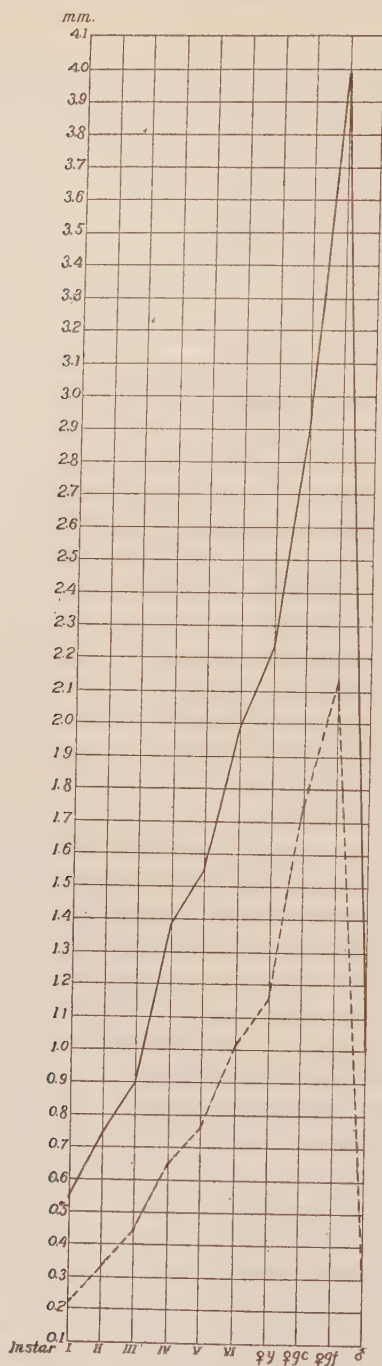


Chart 2.—Relative lengths and widths of body in different female instars and in adult female instars [♀y, young adult female; ♀gc, gravid female from cultures; ♀gf, gravid female from field].

Body size. The data on the sizes of the body at different instars are summarized in table 19 and chart 2. It will be seen that the increases in average lengths and in average widths for the successive instars were quite gradual in the nymphal stage. Length increased perceptibly more in proportion to width. There is a rather sudden jump in both dimensions from the sixth instar to the adult stage. The gravid adults which were raised in cultures were on the average slightly longer and wider than the freshly emerged adults, also from cultures; but gravid adults from the field had considerably larger bodies than those from cultures. As shown by their coefficients of variation either dimension was fairly uniform for each female instar. The differences in average widths and lengths of body in successive instars are given in table 19a.

Mouth parts. The rostrum (pl. 5) was two-segmented in all the instars and the relative sizes, in which the distal segment was about half as long as and slightly narrower than the basal segment almost uniformly obtained throughout the female life history. The rostralis, however, varied visibly in proportion to body, but was not very useful for comparative purposes because of its usually tortuous condition, which made it difficult to measure. (pl. 3.) In general, the recurved rostralis extended almost to the caudal portion of abdomen in the first instar, and the older the nymph grew, the further the distal part of these mouth parts withdrew anteriorly, until in the adult stage, it usually did not reach beyond the posterior margin of the metasternum.

Number of antennal segments in female. The first-, the second-, and the third-instar nymphs bore six-segmented antennae (table 17 and chart 3). No variation from this number was found in any of our material. The same number was likewise noted by us in some of the older nymphs of the fourth and fifth instars, although a large majority of those at this age had seven segments. Most of the sixth-instar nymphs and adults examined were eight-segmented, but some of the specimens of nymphs, as well as adults, had only seven segments, while a few of the nymphs had even as low as six segments.

From a comparative study of the progressive morphogeny of the antennal segments in the different instars the conclusions we reached as to their nature are as follows:

In the first to the third instars, antennal segments 1, 2, 4, 5, and 6 apparently represent simple primary structures that are not subject to modification in the subsequent instars. Segment 3, however, is a complex of three potential segments, the maximum number becoming manifest in the adult stage or even earlier, in the sixth instar. This view is premised, first, upon the fact that as shown in table 18 and chart 3, while the proximal two segments and the distal three segments remain in about the same proportion for all the instars, the segments intermediate between these terminal

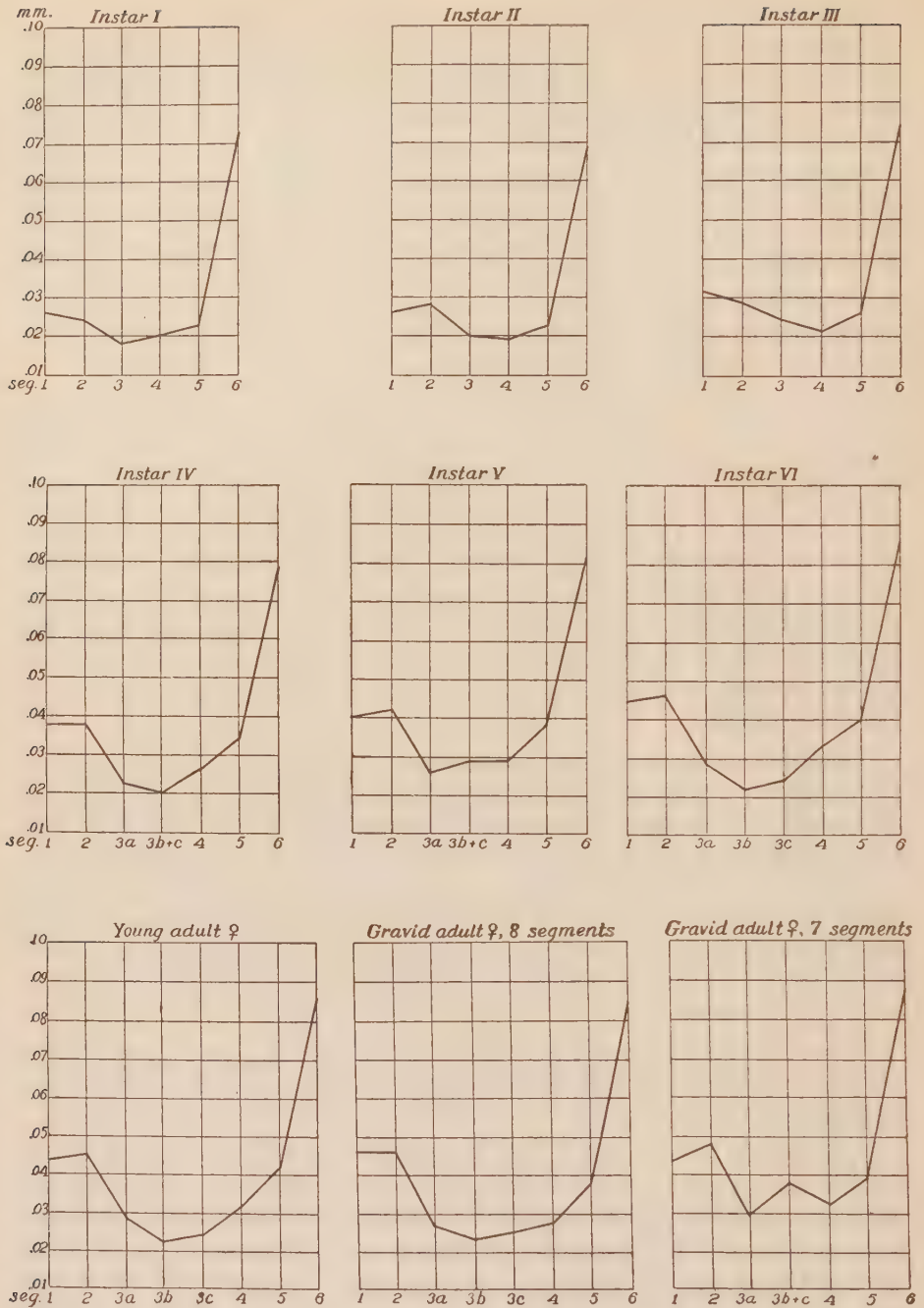


Chart 3.—Relative average lengths of antennal segments, female.

groups not only assume very variable relative lengths but also normally become the smallest from the fourth instar to the adult stage. Likewise, by a comparison of plate 4, figures 1 to 14, it will be seen that the segments in the two terminal groups vary but little in shape while the intermediate ones are markedly non-uniform in this respect.

That the fourth segment in the fourth and later instars with seven-segmented antennae probably arises as a result of transverse division of the third segment, and not from the fourth, of the third instar is shown by the fact that, in relation to the rest of the antennal segments, the third segment from the base becomes perceptibly shorter in the fourth than in the third instar (table 18 and chart 3). The third segment from the apex, which is the fourth segment from the base in the third instar, does not materially change in proportion to the two distal segments when the nymph molts into fourth instar.

In the fifth instar, the fourth segment becomes on the average proportionately longer than in the fourth instar (chart 3). This condition we interpret as a preparatory step to transverse fission of this segment into two, ultimately resulting in the fifth segment of sixth-instar nymphs and adults with eight-segmented antennae. This interpretation is supported by conditions occasionally found in sixth-instar nymphs and illustrated in plate 4, figure 10, wherein the fourth and the fifth segments are imperfectly separated. Moreover, in adults with seven antennal segments the fourth segment is proportionately longer than in the earlier instars, meaning apparently that this segment merely lacks a division in order to show its dual state.

In résumé, therefore, in female *Trionymus*, the third antennal segment which persists unchanged through the third instar normally divides into two upon reaching the fourth instar. The more distal daughter segment again usually divides into two upon reaching the sixth instar. In order to indicate their genetic affinities, we propose the following system of numerical designation for different antennal segments wherein individuals with six-segmented antennae bear numbers 1, 2, $3a+b+c$, 4, 5, and 6; those with seven-segmented antennae, 1, 2, $3a$, $3b+c$, 4, 5, and 6; and those with eight-segmented antennae, 1, 2, $3a$, $3b$, $3c$, 4, 5, and 6.

The minimum number of segments found in adult females was seven. Apparently, as is shown by some of the slide material before us, the nymphs of this form bear six-segmented antennae up to the sixth instar. In the sixth instar, the antennal segments may persist as six or increase to seven, depending on whether or not segment $3a+b+c$ divides into $3a$ and $3b+c$. Ultimately, however, segment $3a+b+c$ always has to resolve itself into at least two daughter segments by the time the adult stage is reached.

Total lengths of antennae. As may be seen from a comparison of the data in tables 17 and 18, which are shown graphically in chart 4, the

antennae decreased considerably in proportionate length to that of body with each successive instar. In the first instar, the antennae were, on the average, one-third as long as body; in the second, about one-fourth; in the third, about one-fifth; in the fourth, a little over one-fifth; in the fifth, somewhat over one-sixth; in the sixth, also somewhat over one-sixth; in the young adult, about one-seventh; and in the gravid adult, about one-twelfth. As

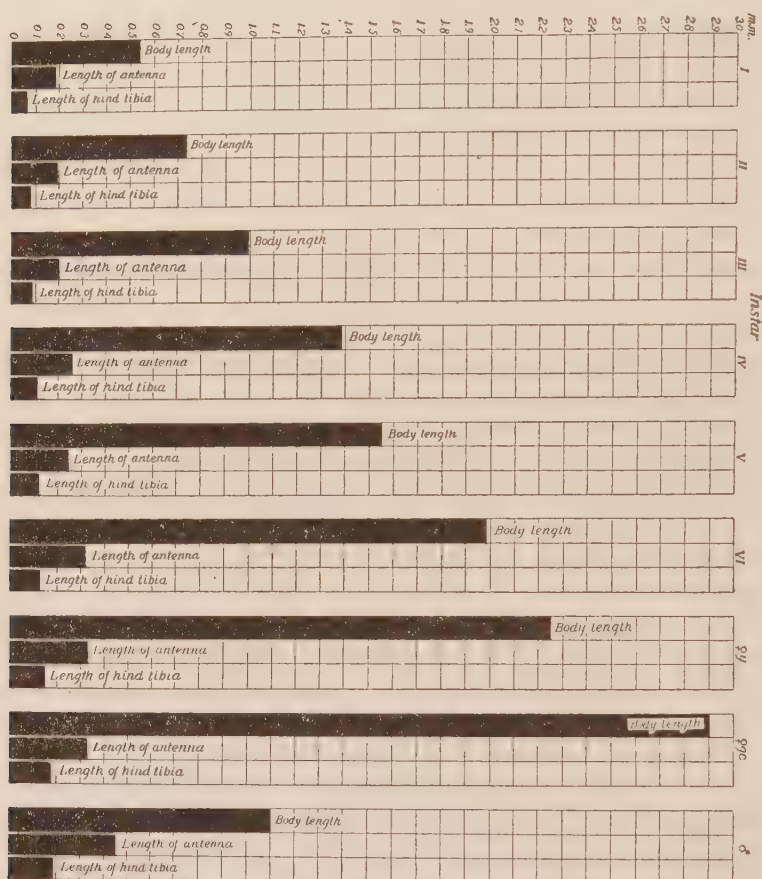


Chart 4.—Relative lengths of body, antennae, and hind tibiae in different female instars and in adult male [♀y, young adult female; ♀gc, gravid female from cultures].

shown by the coefficients of variation, we noted greater dispersion from the average in the fourth, fifth, and sixth instars than in the first, second, and third and the adult stage. These differences in variation are of interest as further supporting our contention with respect to the derivation of antennal segments discussed above. In the first, second, and third instars, segment $3a + b + c$ is not yet undergoing modification, while in the fourth,

fifth, and sixth, this apparently composite segment resolves itself into its ultimate component parts. That the coefficient of variation is somewhat greater in the fourth instar than in the fifth and somewhat greater in the fifth than in the sixth, we take as an indication that the fourth, which is the earliest in which the change first becomes manifest, represents the period of greatest readjustment in segment $3a+b+c$, so that its length or the combined lengths of its subsequent daughter segments are very variable. The almost steadily larger coefficients of variation of segments $3a+b+c$, $3a+b$, and $3c$ as compared with those of other segments in the different instars (table 18) shows the non-uniform, and probably transitional, state of these parts of the body.

Descriptions of antennal segments. The relative lengths of antennal segments are given in table 18 and chart 3, wherein it may be seen that the apical segment is uniformly the longest in the different instars. The shortest is either $3a+b+c$, $3a$, $3b+c$, $3b$, or 4 . Segment 1 is the widest in all the instars, being approximately twice as broad as segment 2. Segments 2 to 6 are subequal in diameter. Segments 1 to 5 are sparsely hairy, with one, two, three or about four spinelike setae on each segment. Segment 6 is conspicuously the most hairy, the setae irregularly covering the entire segment, except the basal fifth, with thicker clustering toward apical part. Frequently, segments $3a$, $3b$, or $3b+c$ bear no seta at all. Segment 1 is subrhomboid or subtrapezoidal in outline in all the instars, 5 is subpyriform, and 6 elongately subellipsoidal. Segments 2 to 4 are usually subcylindrical or subannular, while $3c$ and 4 frequently assume a subglobular or subovoid appearance.

Legs. The three pairs of legs are well developed both in the nymphal and the adult stages. Coxa subovoid, about as wide as, or wider than, long. Trochanter subtriangular from ventral aspect, nearly as long as coxa, about four-sevenths as wide as long. Femur abruptly subfusiform, acute basally, angularly notched entodistally, the tibia hinged at apical prominence. Tibia subcylindrical, pointed basally, truncate distally, sides confluent with those of tarsus. Measurements of femora and tibiae are given in table 19 and chart 5, wherein it may be seen that in all the stages the fore femora and tibiae are the shortest and the hind the longest. In proportion to femur, the tibia is longer in the hind legs than in the middle and longer in the middle than in the fore, except in the fourth instar, where the proportionate lengths of the tibiae in all the legs are approximately equal, and in the sixth instar, where the proportionate length of the tibia is the greatest. Tarsus one-segmented, slightly narrowed apically. Unguis comma-shaped, about two and one-half times as long as breadth at base, Legs very scantily beset with spinelike setae, slightly more so at tibiae and tarsi, especially near entodistal edge of former. One or more erect

simple hairs at ecto-subapical part of tarsus, probably representing the digitules.

Spiracles. Only two pairs of spiracles were distinguishable, the meso-spiracles and the metaspiracles. The former were located about midway between the fore and middle legs, while the latter were nearer the hind than the middle. They were very similar in shape in all the instars, resembling the general appearance of an expanded mushroom, in which the stem part was the spiracularia and the umbrella the peritreme. The measurements of these parts are given in tables 20 and 21. Greater variability was exhibited in the nymphal instars than in the adult.

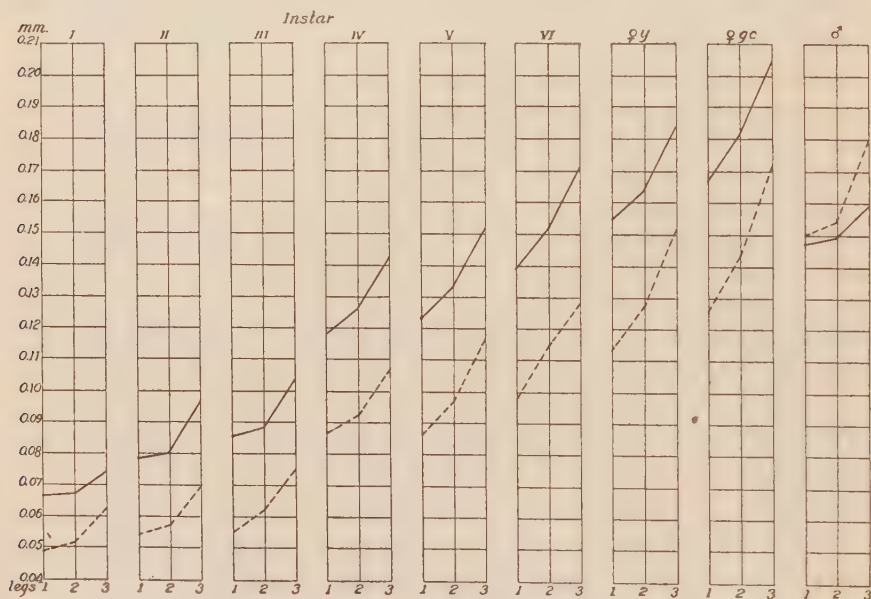


Chart 5.—Relative lengths of femora and tibiae in different female instars and in adult male [♀y, young adult female; ♀gc, gravid female from cultures].

Other body structures. The anal ring with its six anal-ring setae and double irregular rows of cerones, and the anal setae as well as setae in the penultimate abdominal segments were apparently uniform in morphological history throughout the life of the female mealy bug. Likewise, the character and distribution of cerarii showed to us no difference in the different instars. However, the anal lobes, which were prominent in the nymphal instars were very much reduced or absent in the adult.

Separation of the female instars on the basis of body characters. In the following key, the characters used are: number of antennal segments, relative proportions of antennal segments, proportion of length of antennae to that of body, coextension of rostralis with body, and proportions of tibiae and femora. Although the use of proportions of antennal segments

has been advised against by certain coccidologists as valueless for specific diagnosis, in the present work, in view of their rather conspicuous differences and the low coefficients of variation found, we believe we are justified in making use of them in distinguishing the different instars. It is unfortunate that in *Trionymus sacchari* apparently no very satisfactory morphological features are available for this purpose. The number of antennal segments for the nymphs in the present key refers only to normal nymphs of which the adults are eight-segmented. The nymphs of seven-segmented adults retain the six antennal segments practically throughout the nymphal stage, in which case only characters other than number and relative proportions of antennal segments may be used in separating the various instars.

Key for separation of female instars

1. Antennae six-segmented (first, second, or third instar)..... (4)
2. Antennae seven-segmented (fourth or fifth instar or adult)..... (8)
3. Antennae eight-segmented (sixth instar or adult)..... (12)
4. Rostralis usually recurved subdistally near caudal end of abdomen, body about three times as long as antenna, proportion of length of tibia to that of femur in hind legs greater than in fore.....First instar (5)
5. Rostralis usually recurved subdistally midway or near proximal end of abdomen, proportion of length of tibia to that of femur smaller in hind legs than in fore..... (6)
6. First antennal segment at endolateral side shorter than second, body about four times as long as antenna.....Second instar (7)
7. First antennal segment at endolateral side about as long as or somewhat longer than second, body about five times as long as antenna.....Third instar
8. Fourth antennal segment longer than fifth.....Adult (9)
9. Fourth antennal segment about as short as or shorter than fifth..... (10)
10. Third antennal segment longer than fourth, body about five times as long as antenna.....Fourth instar (11)
11. Third antennal segment as short as or shorter than fourth, body somewhat over six times as long as antenna.....Fifth instar
12. Proportion of length of tibia to that of femur subuniform in the three pairs of legs, body about six times as long as antenna. Recurved rostralis usually extending beyond posterior margin of metasternum. Anal lobes more or less differentiated from rest of abdomen.....Sixth instar (13)
13. Proportion of length of tibia to that of femur greater in hind than in fore legs, body seven to nine times as long as antenna. Recurved rostralis usually not reaching posterior margin of metasternum. Anal lobes very much reduced and often undifferentiated from rest of abdomen.....Adult

Eggs. (Pl. 3, fig. 2 and 3.) The eggs were elongately subellipsoidal and creamy white, with the chorion thin and very delicate, rupturing on very light pressure. The following were the measurements based on thirty-two fresh specimens:

Length—minimum, 0.33 millimeter; maximum, 0.58; average, 0.42 ± 0.007 ; coefficient of variation, 14.57 ± 1.23 per cent.

Greatest diameter—minimum, 0.19 millimeter; maximum, 0.31; average, 0.23 ± 0.003 ; coefficient of variation, 5.08 ± 0.43 per cent.

Male adult. (Pl. 8.) General color (dry specimens) dark yellowish brown, wings subopaque. Length and width of body and lengths of femora and tibiae in table 19 and charts 2 and 5. Lengths of antennae and of antennal segments in tables 17 and 18 and charts 4 and 6. Wing expanse about 1.9 millimeters. The body is, on the average, only a little longer than that of a female nymph of the third instar and somewhat less in width than that of a female nymph of the second instar. The length is somewhat more variable than the width, but less variable than the lengths of female instars.

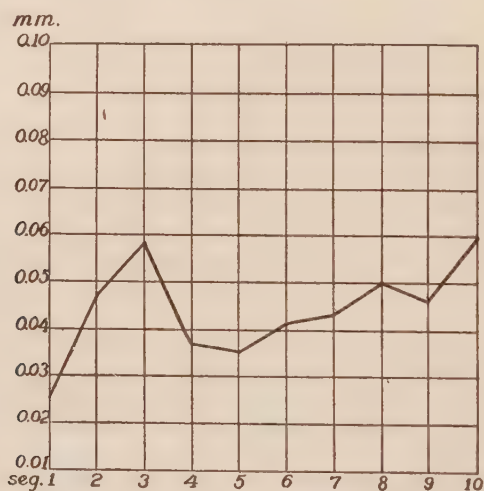


Chart 6.—Relative lengths of antennal segments, adult male.

Head (pl. 8, fig. 10) subglobose, vertex produced rectangularly between antennal bases, about one-third as long as thorax, about as long as wide. Eyes subovate, similar in outline and shape to second antennal segment, lying two-thirds of the way from posterior end of genae to antennal base, not prominent. In slide mounts, another pair of similar dark brown convergent structures, situated anteromesally near vertex. Antennae (pl. 8, fig. 5) ten-segmented, about 0.42 as long as body, about 1.3 as long as antennae of adult female, lengths of segments in table 18 and chart 6. Antennal segment 1 subannular, about one and one-fourth times as broad as 2, about twice as broad as long, scantily beset with hairs (about two) subapically at ental side; 2 subovoid, larger distally, about three-fourths as broad as 1, sparsely beset with hairs at anterior two-thirds, especially at ental side; 3 slenderly subconoid, about 2.8 times as long as broad, about five-eighths as broad as 2, very sparsely hairy subapically; 4 elongately

subovoid, about twice as long as broad, about as broad as 3, sparsely beset with hairs subapically; 5 abruptly subovoid, about 1.6 times as long as broad, about as broad as 4, a few hairs along apical third; 6 irregularly subellipsoidal, about twice as long as broad, about as broad as 5, a few hairs along apical half; 7 elongately subovoid, about twice as long as broad, very slightly broader than 6, a few subapical hairs; 8 elongately subellipsoidal, somewhat incrassate distally, about 2.5 times as long as broad, about as broad as 7, a few hairs along apical two-thirds; 9 irregularly subellipsoidal, somewhat broader toward distal end, length a little less than twice breadth, slightly broader than 8, a few hairs along distal two-thirds, 10 slenderly subovoid, narrower distally, about thrice as long as broad, slightly narrower than 9, a few hairs along entire length.

Thorax about one and one-half times as long as broad, mesonotum occupying nearly four-fifths entire length. Fore wing about two and one-half times as long as broad, Sc subparallel to R, extending to about one-fifth length of wing from humeral angle; R extending to about seven-tenths length of wing, subparallel to costal margin; M about three-fifths as long as R, describing with latter an angle of about 45 degrees, somewhat arcuate basally toward R. Relative lengths of femora and tibiae in table 19 and chart 5; tibiae proportionately longer than femora in the three pairs of legs, much longer in hind than in middle, and somewhat longer in middle than in fore. Tibiae and tarsi conspicuously more hairy than in female, with endoapical tibial hairs very thick and one of these spurlike.

Abdomen about as long as thorax, about two and one-half times as long as broad, slightly narrower caudally. Stylus about 0.08 length of abdomen, subequal in width throughout, rounded at apex. Anal lobes well developed. Longest anal setae about four-fifths as long as abdomen.

Pupa. (Pl. 8, fig. 3.) Light yellowish brown in balsam mounts. Measurements of body and legs in table 19.

Head about one-fourth as broad as thorax, truncate projection of vertex between bases of antennal segment not as marked as in adult. Antennae about one-third as long as body, apparently ten-segmented, segments not plainly defined.

Thorax a little longer than abdomen, about two-thirds as broad as long. Wing pads about one-half as long as thorax, about four times as long as broad; rounded at apex. Legs naked.

Abdomen about 1.4 times as long as broad, no stylus in evidence but caudal conical process present. Anal lobes small, not as prominent as in adult. Longest anal hairs about 0.03 as long as abdomen.

Reproduction in Trionymus sacchari

Swezey (1913), on the basis of his studies in Hawaii, reports that

the eggs are laid in an advanced stage of development, and that they hatch in a few minutes after leaving the female. Egg laying goes on continuously for several days. The inter

vals of time between successive eggs is such that the previously laid ones are mostly hatched before the laying of others, so that there may not be more than one or two unhatched eggs present beneath a female at any one time. The freshly hatched young remain beneath the female for a time before crawling away to locate near her, and this feature easily leads to the idea that the young are produced already hatched. Only by close observation will it be seen that eggs are laid and hatch in a few minutes thereafter. Observations on one female showed that she laid an egg at intervals of about 12 minutes, and the time of hatching of these varied from 15 minutes to half an hour. In hatching, the delicate egg shell or membrane was ruptured in front, and by the squirming of the young bug this membrane was worked backward until free from the egg as in an insect molting.

The foregoing observations have been confirmed in the present work, except in certain particulars which are probably due to the Philippine environmental conditions being dissimilar to the Hawaiian, as well as to possible divergence in interpretation. A detailed record of our results on reproduction are given in tables 1 and 3. In addition to the points which are evident from a cursory examination of the figures in these tables, the following interpretation is made in connection with table 3: (1) The period of fecundity, with an average of 12.29 ± 0.3 days, is fairly uniform, as indicated by the coefficient of variation, which is only 2.69 ± 0.17 per cent. (2) The total number of young produced, average of 200.81 ± 9.92 , during this period, or an average of 16.34 young a day, shows a rapid rate of reproduction which probably either implies that embryonic development requires only a short time for completion or, what is more likely, there are only relatively small differences in age between the older and the younger embryos and feti by the time the mother enters her period of fecundity. That the latter premise is the more tenable is supported by the fact that an average of 20.54 ± 0.43 days elapsed from emergence of the adult female before she could produce her first young (table 1). This period represents only a little less than two-thirds the entire adult life and is 2.65 ± 0.45 days longer than the nymphal stage. Certainly, during this relatively long preparatory period there is ample time for a large number of the germ cells, which, we have reason to believe, are in most cases parthenogenetic, to develop into full-grown embryos.

Our dissections and examination of the contents of the ovisacs of numerous adult females collected on the College Campus, Los Baños, at different times showed that in April, 1930, there were only unsegmented eggs present; in July, 1930, mostly nymphs⁴ and a few unsegmented eggs, the latter, however, being decidedly in the minority; in November, 1931 nymphs⁴ only; and in December, 1930, nymphs⁴ and a very few suspiciously unsegmented eggs. Unfortunately, the present data are not sufficiently continuous from month to month to warrant the drawing of very definite conclusions; but there is enough evidence, especially in the finding of nothing but

⁴These are the "vermiform larvae" discussed later on.

unsegmented eggs at certain times and feti at other times, to indicate that in the Philippine *Trionymus sacchari* does not always lay eggs in an advanced stage of development. Four apparently unsegmented eggs were observed by us in 1930 to take three days—and not several minutes—to hatch. The record is as follows:

Eggs laid.....	September 25, 1930
Hatched.....	September 28, 1930
Nymphs died.....	October 4, 1930

The fact that only unsegmented eggs were found in April, which month in Los Baños is at the height of the dry season, would seem to point to the fact that eggs are produced which do not segment until after laying, possibly as a response to untoward factors in the environment. This inference is suggested by the behavior of a related group of insects, the aphids, which in temperate countries are exclusively viviparous during the more equable summer months and oviparous when the temperature drops in the fall (Uichanco, 1921). Unsegmented eggs apparently continue to be laid by *Trionymus*, until about July, the beginning of the heavy rains. From July until about November, which are the rainy months, when environmental conditions are generally less unfavorable, a modification in the method of reproduction takes place. The eggs, at least in most of the mothers, proceed to develop *in utero* and usually, as has been determined by dissection of abdominal contents of adult females, are fully formed nymphs ("vermiform larvae") by the time they pass out through the vaginal slit. The females in this condition are apparently ovoviviparous. Time and again we have taken recently born young that for several minutes superficially simulated eggs—elongately subellipsoidal or vaguely subfusiform, with the surface area seemingly uniformly smooth. When the nymph began to escape from its inclosure, however, we invariably found upon close watch under the microscope that the investing layer, instead of being a straight, simple capsule, as an egg-shell of a coccid should be, followed closely the contours of the body, like a tight-fitting jacket. As the insect wriggled out, the antennae and legs were seen to withdraw from their investing sleeves. Hence, the process is not one of hatching, as Swezey apparently mistook it to be; it represents the first post-embryonic molt.

Molting within a few minutes after hatching from the egg is, indeed, probably a more common phenomenon in certain orders of insects than is generally supposed. La Baume (in Bücher, 1918), Mikhelson (1922), and Nikolskii (1925) have previously observed this behavior in various species of migratory locusts. Uvarov (1928, p. 41) has termed this stage "vermiform larva." We have, likewise, noted a similar occurrence in newly hatched *Gastrimargus marmoratus* Thunberg,⁵ a common species of locust on the

⁵Determined by Dr. B. P. Uvarov, British Museum (Natural History).

College Campus at Los Baños. To our knowledge, however, the existence of vermiform larvae, as defined by Uvarov, has not hitherto been recorded outside of the Orthoptera.

In *Trionymus sacchari* ovoviviparity is probably concomitant with parthenogenesis, as may be inferred from the fact that the majority of the fully developed embryos in ovoviviparous mothers were found located in the ovarioles where they could not have been subject to exposure to spermatozoa, which in insects are discharged through the mouth of the spermatheca into the vaginal cavity. This species has been proved by us in the laboratory to be able to reproduce parthenogenetically. The one hundred and sixty-four individual females reported on in table 1 and the fifty-seven in table 3 were confined separately from the time they were first-instar nymphs, and could not possibly have had access to males either from the containing jars or from the sugar cane stems, because these had been previously cleaned thoroughly and the surfaces wiped dry. The cloth covers of the jars during the experiment were kept securely tight by means of strings. It will be noted in table 3 that these virgin females each produced an average of 200.8 ± 9.9 young. These figures are sufficiently large to show that parthenogenesis is a normal process in *Trionymus sacchari*, and is not merely occasional or accidental.

It is doubtful if in this species parthenogenesis and amphigony represent sharply demarked, mutually exclusive seasonal phases in the yearly cycle of generations of this species. Males were bred by us in abundance toward the end of September, 1929 (rainy season), March, 1930 (dry season), and May, 1931 (end of dry season). During the period covered by the present investigations, they were apparently scarce in the other months. Quite possibly, in any given locality, the two methods of reproduction are co-existent, one supplanting the other as called for by particular sets of variable factors obtaining at the time in the host plant or in the immediate limited physical surroundings of the individual mother. The fact that the mothers which counted males among their offspring each produced an average total of only 101.5 ± 4.45 young, as against exclusively female-bearing mothers each of which gave rise to an average total of 200.81 ± 9.92 young (table 3), is an indication that appearance of male zygotes in the ovaries is probably a sequel to lowered maternal constitution. We take it that such considerable reduction in procreative ability, to almost one-half, must have been due to the vitality of the mother being so lowered that she was unable to sustain in her reproductive system a larger number of developing young. Likewise, the relative rarity of cases in which males were reared in our cultures and the small proportion to females, average of 8.76 ± 1.42 per cent of the total number of offspring of each male-producing mother (table 3), may probably be taken to mean that under Philippine conditions amphigonous reproduction is a casual, rather than habitual, event in *Trionymus*

sacchari. This contention is further reinforced by the coefficient of variation, 72.15 ± 10.886 per cent, which shows that the males are very erratic in their occurrence even under circumstances which call for it. Moreover, the male is very short-lived, the average span of adult existence being only 3.87 ± 0.32 days (table 11), as compared with that of the female, which is 35.15 ± 0.62 days (table 3). If this supposition is correct, this species of mealy bugs presents a condition which closely approximates that in Philippine and other tropical Aphididae wherein, however, the male sex is apparently absent and the females exclusively parthenogenetic at all seasons of the year.

Oviparity probably occurs side by side with ovoviviparity in any month, the existence of one method or the other being similarly determined by extremely localized modifying influences. It must be pointed out that the simultaneous existence of the two reproductive processes does not work against the idea of their at least indirect relation with certain climatic factors, since in the Philippines the hot, dry months do not bring about a general complete cessation of vital activities in plant and animal life in the sense that the onset of low temperatures in the fall in the temperate zones marks the beginning of a period of hibernation. In the height of a Philippine summer, with the ground parched owing to a prolonged drought, most plants do not shed their leaves and certain insects, especially the scales and the mealy bugs, even become markedly more abundant.

Probably indicative of a rather general occurrence, at least in the tropics, of ovoviviparity, and its possibly concomitant parthenogenesis, in mealy bugs are three other species, *Pseudococcus natalensis* Brain, *P. brevipes* Cockerell (= *bromeliae* Bouché), and *Monophlebus fulleri* Cockerell, which were recorded by Brain (1915) as "viviparous" in the South African specimens he studied. In the Philippines, one of the authors (Uichanco) observed ovoviviparity in dissections of *Ferrisia virgata* (Cockerell), *Antonina zonata* Green, and *Coccus viridis* Green from material collected on the campus of the College of Agriculture. Perhaps a more careful survey of large series of specimens of different forms carried at fairly regular intervals over a period of at least one year in a given locality will yield highly interesting sidelights on this question in connection with the Coccidae.

Life history of Trionymus sacchari

Comparison of insectary methods. As has been stated earlier in this paper, the procedure we finally adopted in life-history observation for this species was to rear the mealy bugs individually in battery jars on cut sugarcane stems. The feed was not changed during the duration of each culture. The lower ends of the stems were not set in water, and in fact no attempt was made to conserve the plant materials other than to keep them from direct sunlight. For convenience in discussion, we shall term this the

battery-jar method. In order to be reasonably certain that this treatment of the mealy bugs was not so drastic as to produce appreciable deviations from possible life-history results under natural conditions, we checked up our data from the battery-jar method with those on mealy bugs with which these were coëtaneous but reared on potted sugar-cane plants (tables 4 and 5). Conditions in the potted plants obviously would more closely approximate those obtaining in the field. The differences are relatively very small and, except possibly in the case of the second stadium in the January to February, 1931 sets, not significant. The discrepancies between the two methods in life cycles that covered about 30 to 40 days were only somewhat over one day and, as shown by their probable errors, inconsequential. It may safely be assumed, therefore, that the results in the present life-history observations by the battery-jar method are as close to normal as we can possibly expect under insectary conditions. This is especially so when we consider that the unit we used in measuring intervals of time was one day and the periods between inspections were not of exact 24-hour lengths.

Incubation period. On account of the tendency of *Trionymus sacchari* to ovoviviparity, an incubation period, as exhibited by eggs of most insect species that do not begin to segment until shortly before or even for some time after laying, perhaps has no strict application in the present case. We have been unable to determine whether an ovoviviparous mother does under certain conditions become oviparous merely because of postponement in the hatching of young until after the eggs are laid or these two reproductive phenomena are separate and exclusive features whereby certain mothers are capable of producing nothing but eggs that do not hatch until after about three days from laying and others nothing but living young.

The young are extruded through the vaginal slit into the ovisac as vermiform larvae. Our observations on forty female vermiform larvae showed an average duration of 28.7 ± 0.48 minutes from birth until the casting off of their pellicles and changing to first-instar nymphs (table 1).

Nymphal stage of the female. The female mealy bug was observed by us to molt six times before attaining the adult stage (table 1). This number is more than the maximum of four that has been generally observed in Coccidae (MacGillivray, 1921, p. 9; Comstock, 1930, p. 448), and we would have seriously doubted our own results if we had not taken the precaution to remove carefully the exuviae after every observation and recording. The durations of the different stadia are given in the same table. They are fairly uniform, surprisingly so, for the 164 cultures, as shown by their coefficients of variation. The differences in duration between successive stadia are only matters of one day or a fraction of one day, the first stadium, which is the shortest, lasting for only 2.48 ± 0.02 days, and the sixth stadium, the longest in the nymphal stage, 3.71 ± 0.05 . The entire nymphal stage cover-

ed an average period of 17.89 ± 0.15 days, with a coefficient of variation of 15.76 ± 0.59 per cent, which is considerably less than that for the adult stage, or 19.7 ± 1.25 per cent (table 3). The first-instar nymphs are very restless, and probably do not remain long in the ovisac but soon escape in order to locate themselves on suitable sites on the host plant for feeding. Perhaps from this period up to the third instar dispersal largely takes place, the nymphs spreading both by their unaided power of locomotion and, more effectively, through the agency of friendly ants. The fourth and older nymphal instars continue to move about, although to a considerably restricted extent. The waxy coating of the body which begins to become manifest in the third instar becomes increasingly profuse as the nymph grows older.

Adult life of female. The average duration of the different events in the adult life of the female are given in tables 1 and 3. The average length of time intervening between emergence of adult and production of first young showed the greatest variability among all the phases in the life history of the female (table 1). The fact that its coefficient of variation is 40.07 ± 1.49 per cent, while that of the total duration of the adult stage is only 19.70 ± 1.25 per cent (table 3) may easily be mistaken to mean that, because the allotted span of adult life in female *Trionymus* is fairly uniform, the earlier she begins to exercise her procreative functions, the more days will there be available for her to produce young. That such is not the case is shown by the coefficient of variation of the period of fecundity, 2.69 ± 0.17 per cent, which indicates very close uniformity. On the other hand, the females survived their period of fecundity by a minimum of 1 day, maximum of 6 days, and an average of 1.54 ± 0.29 days (table 3). It should be noted in this case that the coefficient of variation is 70.78 ± 4.47 per cent, indicating a very high degree of variability. Hence, with the total duration of the adult stage and the period of fecundity fairly uniform, as they are, the logical deduction is that the two periods in the adult life at either end of the period of fecundity tend to balance each other so that whatever gain or loss in time is effected between emergence and production of first young conversely affects the period of survival after the mother concludes her reproductive term. Again, it should be noted (table 3) that the coefficient of variation for the total number of young produced by each female is 54.87 ± 3.47 per cent, indicating that within the fairly uniform span of time covered by the period of fecundity the rate of reproduction differs considerably for each individual mother, so that slight lengthening or shortening of the time within the normal limits probably would not alter the number of her potentially successful offspring.

The adult female mealy bug is sedentary in her habits and remains hidden, usually between the leaf sheaths and the stem of the host plant. The location is largely above the surface of the ground, but frequent cases are found where colonies of *Trionymus sacchari* infest even the underground

stems. The adult can easily be distinguished in the field with a little practice because of the much thicker coating of powdery white wax, especially toward the caudal end of the abdomen.

Life history of the male. On account of the rarity with which sets were found that produced males, only a total of 31 males could be studied individually in the present life-history observations. The younger male nymphs could hardly be distinguished from those of the females until about the fourth instar, so that when materials were isolated it was a matter of chance that males were included here and there among individual cultures. The male was found to go through five nymphal instars, the entire nymphal stage covering an average of 14.58 ± 0.3 days (table 2). The number of molts in our results is again at variance with the usual number of four found elsewhere by other workers (MacGillivray, 1921, p. 8; Comstock, 1930, p. 448). Two of the stadia, the third and the fifth, had much higher coefficients of variation than the others; these were, respectively, 77 ± 6.6 and 40.64 ± 3.48 per cent. However, they are probably due more to the small number of cultures than to any generally applicable biological peculiarity. The pre-adult life (nymphal plus pupal stages), which covered 21.03 ± 0.41 days, was longer by 3.14 ± 0.43 days than the nymphal stage of the female. The adult, however, which lives for only 3.87 ± 0.32 days after emergence is certainly a very ephemeral creature. It is tiny and exceedingly delicate. Remembering, in addition, that it is relatively a rarity, its importance in the social economy of the species must indeed be very dubious.

Effect of climatic factors on life history and reproduction

An appraisal of the criteria used. The climatic factors used were: (1) Mean monthly temperature. (2) Average monthly maximum temperature. (3) Average monthly minimum temperature. (4) Mean monthly relative humidity. (5) Total monthly rainfall. (6) Number of days of rainfall. The more satisfactory procedure would have been to use air-conditioned chambers wherein relative humidity and temperature could be maintained in varying proportions, but in the absence of such facilities, resort had to be had to the less direct and admittedly much less accurate method of measuring the effect of variations of normal atmospheric conditions on cultures conducted in the uncontrolled air of the insectary. In the absence of data for temperature and humidity immediately surrounding the breeding jars we had to utilize the weather records of the Department of Plant Physiology, which represent average conditions for two stations on the College Campus. Inasmuch as the insectary is located approximately half-way between these two weather stations the use of this substitute is in part justified, since variations registered in those records would presumably be uniformly reflected in the almost open-air condition in the insectary.

In view of the length of the life cycle, we deemed it inadvisable to take it as a basis for measuring effect on life history, because it would not fit in

with the monthly weather records but would extend in all cases through fractions of adjoining months. For this reason we used instead the length of the nymphal stage which has the advantage over the other alternative criteria in that it is short enough to allow a more satisfactory plotting, but not so short as to admit of undue possibility for inherent error in observation. Moreover, it represents the stage in the life history of the insect in which initial adaptation to environmental factors takes place and therefore where fluctuations in modifying influences would be most far-reaching. The only handicap in the use of this criterion is that the coefficient of variation (table 1) is relatively small, which means that response to varying sets of conditions would not be so conspicuously marked.

Likewise, for lack of other means, we had to utilize the records for number of days from emergence to first appearance of young in evaluating effect on reproduction. Shortness of period in insects from assumption of adult stage until production of first young may probably be due either (1) to conditions being so favorable that no delay is occasioned in the exercise of procreative functions or (2) to conditions being so unfavorable that, as has been commonly observed, not only in many animals but also in flowering plants, the mealy bug responds by making a desperate effort to perpetuate its kind through precocity in reproduction.

In general, the main difficulty encountered in the present method is the small number of cultures that could be utilized. Out of about 200 successful cultures, only 49 could be satisfactorily grouped together as representing nearly contemporaneous sets. Narrowed to months, this already small number had to be further arranged in small lots, which consisted of only from 4 to 7 cultures each, in addition to two with only 2 each.

Results. The results are embodied in tables 6, 8, 9, and 10, and in charts 7, 9, 10, and 11.

As may be seen in chart 7, supplemented by the climographs, in general, within the temperature ranges that obtained in the present series of observations, the fluctuations of the curve for the length of nymphal stage tended to follow approximately the upward trend of the curve for the mean monthly temperature range. On the other hand, under the same sets of temperature fluctuations, the lower the mean monthly temperature the longer the period from the emergence to first appearance of young.

Although relative humidity followed somewhat irregularly the trend of the temperature curves, its effect on the length of the nymphal stage, as well as on that of the period from emergence to appearance of first young, is apparently indirect, in that it serves to temper the rigors of the higher temperatures, perhaps in the way of minimizing undue evaporation.

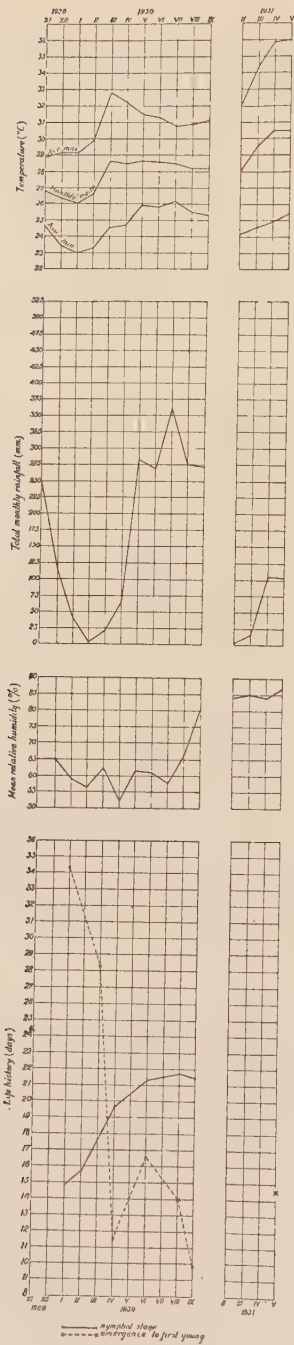


Chart 7.—Relation of lengths of nymphal stage and period from emergence of adult to production of first young to climatic factors (College).

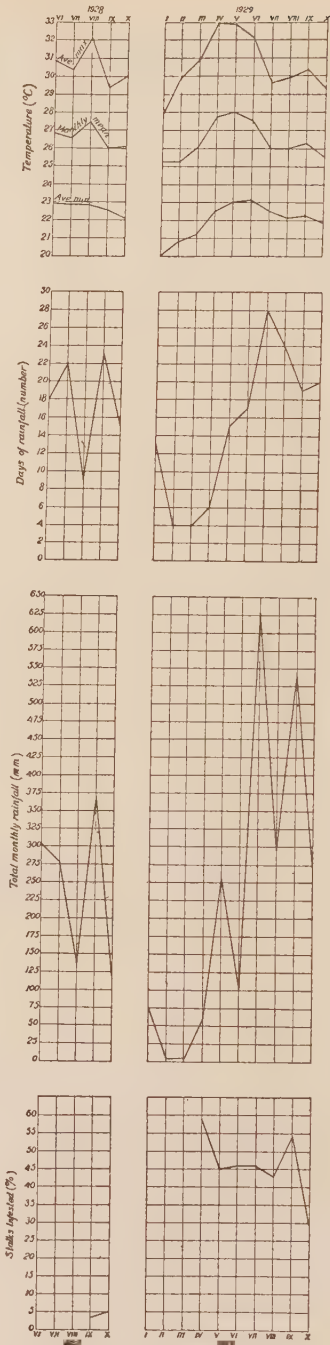


Chart 8.—Relation of degree of infestation to climatic factors (Canlubang).

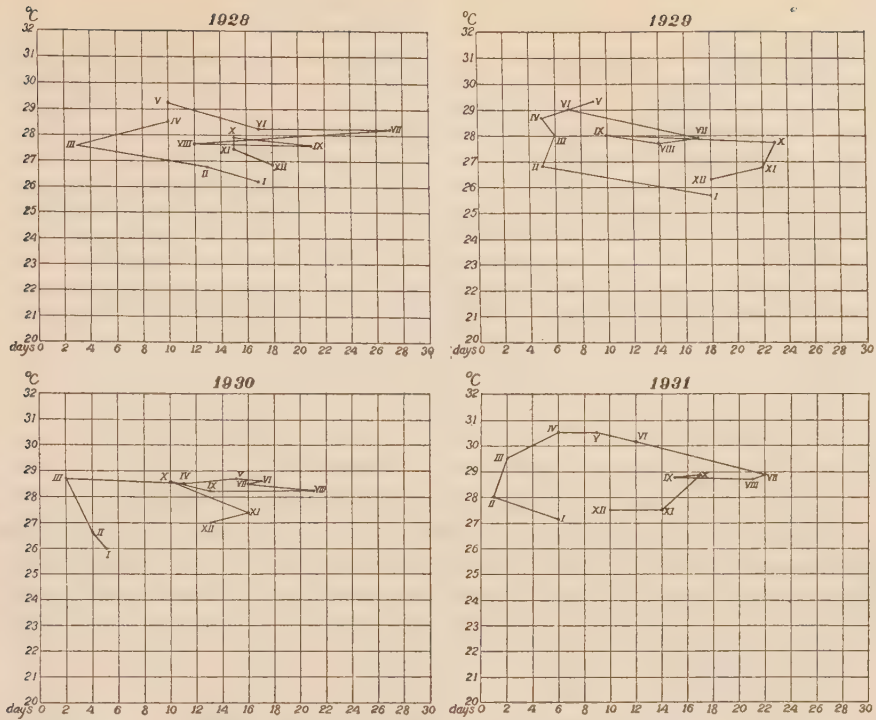


Chart 9.—Temperature-days of rainfall climographs, College of Agriculture, 1928, 1929, 1930, and 1931.

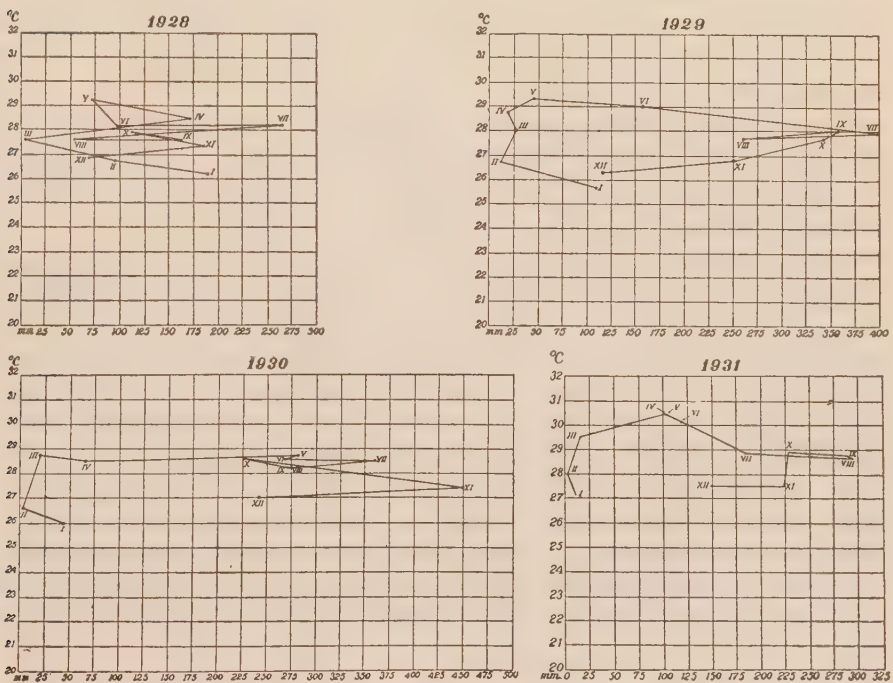


Chart 10.—Temperature-monthly amount of rainfall climographs, College of Agriculture, 1928, 1929, 1930, and 1931.

pronounced effect of these small changes in environmental factors in January and February presumably indicated a better physical trim in the mealy bugs, thus enabling them to maintain a more delicate sensitivity in their mechanism of response to external stimuli. Moreover, the almost steady rise in the curve for nymphal stage, from January, 1930, through the several months following (chart 7) presumably shows that the rise in temperature from February on followed a receding course from the optimum point in the zone of effective temperatures.

In order to ascertain the aggregate effect of these small specific reactions of the insect to temperature and relative humidity, our life history records were rearranged into two groups as follows: (1) Records which coincided with months in which mean relative humidity was below 80 per cent; these were November and December, 1929, and January to August, inclusive, 1930 (108 cultures). (2) Records which coincided with months in which mean relative humidity was above 80 per cent; these were July and August, 1929, September to December, inclusive, 1930, and January to May, inclusive, 1931 (54 cultures). It will be seen that the foregoing classification does not follow the ordinary division of the year into a dry and a rainy season, which in Los Baños occur in January, February, March, April and May, and in July, August, September, and October, respectively (Estioko, 1925). As shown in the climographs for 1929, 1930, and 1931 for the College, percentage of relative humidity, although proportionately greater for a particular year as the local annual rainfall increased, was subject to wide monthly variations independently of season and local rainfall in the months immediately under consideration. Grouping has been made according to humidity and not according to temperature, because the former is the more variable. Rainfall has not been considered in the present correlation, because, under the sheltered condition in the insectary, it could have no possible effect on the life history except indirectly as more or less influencing relative humidity. The results are given in tables 11, 12, and 13. The last is a summary of the preceding two tables, wherein it may be seen that the most outstanding difference, as is to be expected, is observable in the total duration of life cycle, which was longer during periods of low relative humidity than in those of high by 4.04 ± 0.586 days. The probable explanation is that the lengthening of the life cycle is the result of unfavorable conditions due to the effect of high temperature side by side with low relative humidity. A similar reaction to high temperature has been observed in our laboratory in another homopteron, *Perkinsiella vastatrix* Breddin, Delphacidae (Urbino, 1927).

The length of the nymphal stage in *Trionymus* shows no significant difference in the present correlation. That it was short when the monthly temperature and relative humidity were equally low (chart 7), lengthened when the temperature rose but relative humidity remained low, and again

shortened when humidity reached above 80 per cent although temperature continued in its upward trend is a further indication of the rôle of relative humidity in determining temperature tolerance of this mealy bug.

Relation of degree of infestation to climatic factors

In the present survey, the criterion used for evaluating degree of infestation was the number of stalks infested rather than the number of mealy bugs found on each stalk examined. In an insect, like *Trionymus sacchari*, which is soft and delicate and in which the power of independent movement is relatively very limited, the problem of dispersal is obviously of prime importance. Once established in the protective shelter between the cane leaf sheath and stem, the question of multiplication must be a secondary matter, especially in view of the fact that, as has been shown earlier, this species exhibits a strong tendency toward parthenogenesis. Such complicating factors as natural enemies would not, in our judgment, vitiate results from the present method of survey, inasmuch as active dispersal, which occurs largely in the first-instar nymphs, comes as a sequel to an unhampered prolificacy; and a weak mealy-bug colony cannot, of course, reproduce efficiently. Moreover, fluctuations in prevalence or scarcity of important natural enemies like the fungus *Aspergillus* (probably *flavus* Link), are equally largely influenced by prevailing physical factors in the environment.

One possible criticism against the method herein followed is that the canes considered in the different surveys were of varying ages; but, as explained later on, errors from this source are apparently negligible. Another possible objection is that there is a gap of five months intervening between 1928 and 1929. The situation, however, although undesirable, could not be remedied, inasmuch as in this neighborhood harvesting of canes after maturity around October, preparation of the field for the subsequent crop, and the allowance of two or three months that has to be made after germination, make this blank period obligatory. Likewise, on account of the relatively short time of less than two years in which this part of the investigation was carried on, the conclusions made in connection with the present part of the paper are admittedly very tentative.

The climatic factors used were mean monthly, average maximum, and average minimum temperatures, and number of days of rainfall and quantity of total rainfall for each month at Canlubang. Unfortunately, data for relative humidity for the periods covered could not be obtained; but, as may be seen on comparison of the climographs for the College (charts 9, 10, and 11), at least the relative annual trends of this factor may be surmised roughly from the trends of rainfall.

Tables 14 and 14a give the percentages of infestation of the twelve cane varieties listed in table 15 at each survey made at Canlubang. Chart 8 is a graphic summary of table 14a for purposes of correlation with the

various physical factors of the environment. Table 8 and charts 12 and 13 give the quantities of rainfall, the number of days of rainfall, and mean monthly temperatures at Canlubang for the years 1928 and 1929.

The very wide difference in percentages of infestation in September and October, 1928, with the much higher rates in approximately corresponding periods in 1929 is outstandingly marked in chart 8. We adduce two probable causes for this remarkable contrast: (1) The prevailing temperature ranges around that period in 1928, and more especially in the month im-

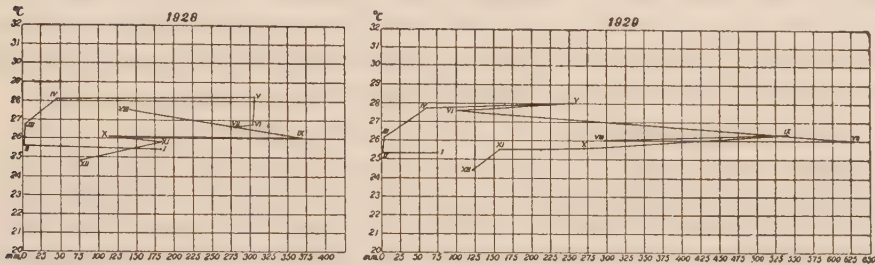


Chart 12.—Temperature-monthly amount of rainfall climographs, Canlubang, 1928 and 1929.

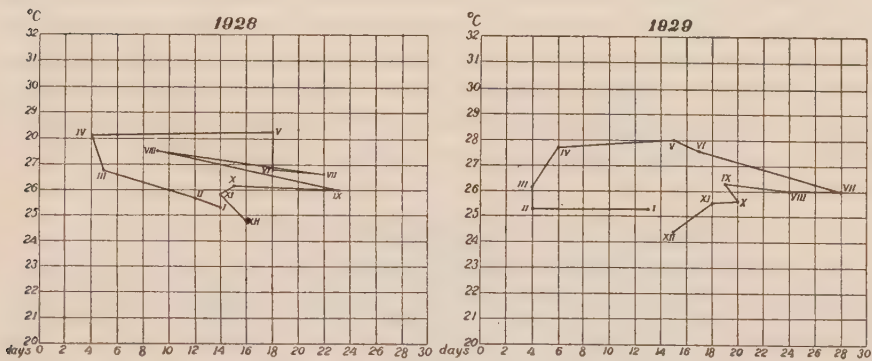


Chart 13.—Temperature-days of rainfall climographs, Canlubang, 1928 and 1929.

mediately preceding each survey, were higher than in the corresponding periods in 1929. The average maximum temperature for August, 1928, particularly, was 32.1°C., as compared with that of August, 1929, which was only 29.9°C. Both temperature ranges extend far above the apparently optimum temperature for *Trionymus sacchari*, which, as discussed under relation of length of nymphal stage to climatic factors, is probably around 26°C., and the higher the temperature rose from this point the more unfavorable conditions became for the insect. Moreover, total monthly rainfall for each of the months of August, September, and October, 1928, was considerably less than in the corresponding months in 1929, and it is

to be supposed that as a consequence relative humidity was correspondingly less also. It has been shown elsewhere that a higher relative humidity apparently tempers the rigorous effect of otherwise very unfavorably high temperature on the mealy bugs. Perhaps conditions of high temperature and low relative humidity so weaken the physical constitution, in addition, that outbreaks of entomogenous diseases further aggravate matters for the mealy bugs. (2) As may be seen by comparing the climographs for Canlubang, the year 1928 was in general characterized by a wider range of temperature, especially in the upper limit, than in 1929. On the other hand, the range in frequency of rainfall and the monthly quantities of rain was smaller in 1928 than in 1929, with their probably corresponding sequel with respect to percentage of relative humidity.

Rainfall apparently exerts a direct influence which is independent of temperature. A month of especially copious rainfall is followed by one with comparatively less infestation, probably owing to the migrating first-instar nymphs being washed out and killed by the heavy rains. The effect, however, is relatively very temporary, the depleted ranks being quickly reënforced through reproduction in the subsequent months when there is less precipitation.

It must be emphasized at this juncture that the effects of the modifying physical factors in the environment discussed above on percentage of infestation become apparent, not immediately during the month in which a given set of conditions prevails, but in at least about the month following. This behavior is readily explained by the fact that it takes the female *Trionymus sacchari* on an average about six weeks to complete a life cycle.

Relation of degree of infestation to age of cane

The twelve different inspections reported on in table 14 included the various varieties of canes considered in the experimental work at Canlubang. The ages ranged from four to ten months. It may be seen from the table that fluctuations in percentage of infestation were apparently independent of the age of the cane. Likewise, it must be pointed out, by way of lending further weight to this argument, that in table 15, wherein the average infestation for each variety at different ages was considered, the coefficients of variation were small, ranging from 0.25 ± 0.068 per cent to 0.69 ± 0.11 per cent.

The very young canes, about one to three months, are probably an exception, although it is difficult to detect presence of mealy bugs at these ages. It must be borne in mind that even propagation points may harbor mealy bugs which have been carried over from the parent fields and, in the case of ratoons, this pest may remain viable for a considerable length of time in cane stubble. The seeds of infection are, therefore, always immediately

present, so that failure to detect mealy bugs on the young shoots does not necessarily mean freedom from attack.

Degree of susceptibility of various sugar-cane varieties to Trionymus sacchari

In the present survey which was conducted at the Calamba Sugar Estate for over one year, from September 17, 1928, to October 26, 1929, only twelve varieties could be considered because they were the only ones available at the time in sufficiently large numbers for adequate random sampling. Fifty hills were examined at each inspection, every plant on each hill being gone over carefully. Care was taken to choose hills in scattered locations in the field, in order that as nearly a representative condition of the cane population as possible could be established. The ages of the canes ranged from four to ten months, as indicated in table 14, wherein may also be found listed the dates covered by the different inspections.

It may be seen in table 15 and chart 14 that the varieties at first glance seemed to differ considerably in degree of susceptibility, C. A. C. 87 showing the least, with 29.24 ± 4.8 per cent of the stalks infested, while 2727 P. O. J. and 2714 P. O. J. considerably overtopped the others. However, upon taking Cebu Purple as standard of comparison, it was found (table 16) that the differences with this variety in percentages of infestation were not significant, except possibly in the case of the two P. O. J. canes, which was only doubtfully significant. That the figures obtained for these various cane varieties did not show important discrepancies is further indicated by the very low coefficients of variation, which ranged from only 0.06 ± 0.09 per cent to an exceptional one of 0.64 ± 0.096 per cent, when the average percentage for all the varieties was taken for each inspection (table 14).

It is unfortunate that 2878 P. O. J., which is now an increasingly popular variety in certain parts of the Philippines, could not have been included in the survey. The varieties used in the present work, however, sufficiently show that probably no cane variety is distasteful enough to *Trionymus sacchari* to make control through prospective development of resistant strains worth attempting. On the other hand, there are varieties to which the pest apparently has special attachment, as in the case of 2727 P. O. J. and 2714 P. O. J. Unless such varieties show certain markedly desirable qualities which would tend to offset this possible handicap, planting of these should be discouraged so as not to help stimulate *Trionymus* infestation.

Ants associated with Trionymus sacchari

During the course of the present work, seven species of ants were found attending *Trionymus sacchari* in the sugar-cane field at Los Baños and at Canlubang. Of these, the most abundant, and, hence, presumably the most serviceable to the mealy bugs were: *Solenopsis geminata* Fabr. subsp.

rufa Jerdon⁶, *Paratrechina longicornis* Latr., *Paratrechina* (*Nylandria*) sp., and *Polyrhachis* (*Myrmhopla*) *dives* Smith. The first three were especially important to the pest because they not only acted as alert defenders against invading foes but also as efficient agents of distribution of the mealy-bug

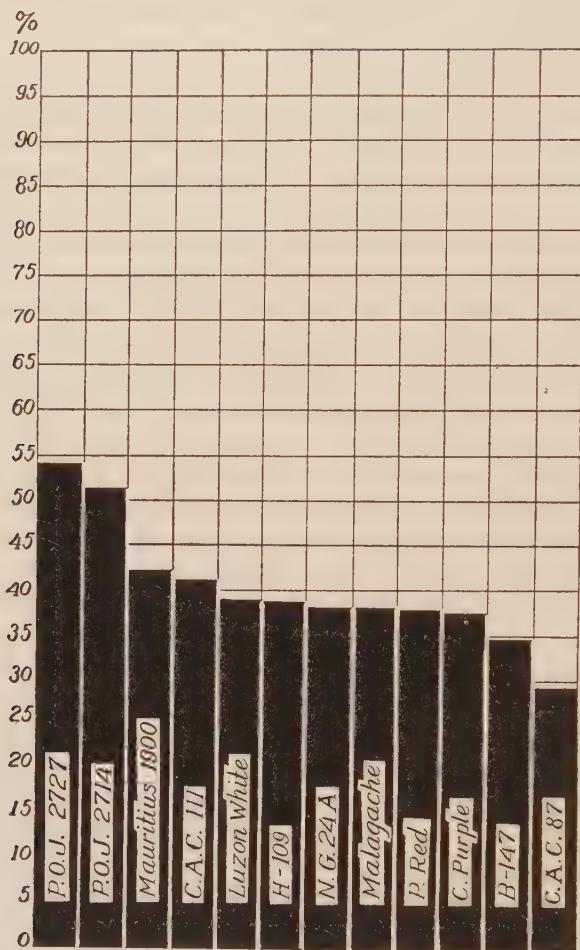


Chart 14.—Relative susceptibility of twelve sugar-cane varieties (Canlubang).

nymphs, which they picked up with their mouth parts and carried to suitable locations. The last named species, on the other hand, seemed to be only partially solicitous for the welfare of *Trionymus* colonies; these ants apparently confined themselves to police duty. The following additional species were occasionally encountered among mealy bugs, but probably, in

⁶All the ant determinations by Dr. J. W. Chapman.

their rôle of unsteady and itinerant callers, they accomplish but little in the way of enhancing the pests' welfare: *Camponotus* (*Tanaemyrmex*) *barbatus* Rog. subsp. *taylori* Forel, *Tapinoma* (*Micromyrma*) *melanocephala* Fabr., and *Monomorium* (*Monomorium*) *floricola* Jerd. var. *philippinensis* Forel.

Natural enemies

Of the different enemies of *Trionymus sacchari*, the most effective in Los Baños and Canlubang, and from all indications, in other parts of the Philippines also, is the common ascomycetous fungus *Aspergillus* (probably *flavus* Link). The fungus is of very wide distribution in the Philippines and, in parts where there is a seasonal distribution of rainfall, is more especially prevalent during the rainy season. In our vicinity, the high peak of infectiveness seemed to occur in October and November, toward the concluding part of the rainy season, when colonies of mealy bugs were frequently noted to consist of an almost solid mass of mummified insects with the surface of the skins thickly covered by yellowish brown fungous fruiting bodies.

A number of parasitic enemies were also found and they, too, together with the predators, probably help considerably in reducing mealy-bug infestation. Three apparently different species of *Anagyrus*⁷ were frequently encountered in the course of our work. Swezey (1931) records that at least one of the present species of *Anagyrus* is close to *dactylopii* (Howard) of Hongkong. This author, moreover, speaks of the introduction of this parasite into Hawaii from the Philippines in 1930 and, at the time of his writing, of its recovery from two regions there, where it goes through a new generation every two or three weeks.

Of the predators, the most common were Coccinellidae, *Cryptogonus orbiculus* Gyll., *Pullus* sp.,⁸ and two other apparently distinct forms, which were all quite common, and, in addition, a fifth relatively rare species; two species of Forficulidae, *Proreus simulans* Stål and *Chelisoches morio* Fabr., both of which were reported on earlier by Urbino (1927) as predators on *Perkinsiella vastatrix* and which in the present work was observed to feed on nymphs of *Trionymus*; and an unidentified capsid bug, which is apparently not conspecific with the one recorded by Urbino on *Perkinsiella*. Certain dipterous larvae were, likewise, observed to feed on nymphs. Goseco (1932) records *Gitonides perspicax* Knab (Drosophilidae) as possessing this curious habit in Negros, and very likely we were also dealing with this form in our cultures. One species of cockroaches subsisted both on waxy secretions and on nymphs. A species of cheese mites of the genus *Rhizoglyphus*⁹ attacked the bodies of both young and adult mealy bugs.

⁷Identified by Mr. C. F. W. Muesebeck, U. S. National Museum.

⁸Introduced into Hawaii in 1930 but not yet recovered (Swezey, 1931).

⁹Identified by Dr. H. E. Ewing, U. S. National Museum.

The following insects were found associated with the mealy-bug colonies, but were apparently only scavengers, eating up detritus and waxy secretions: at least eight species of beetles, one of which was a histerid, and a species of lepidopterous larvae.

Fungi associated with mealy-bug colonies

The following fungus species were observed in our cultures on canes which were used as feed for *Trionymus sacchari*, especially during the rainy season: *Melanconium sacchari* Mass. (Fungi imperfecti), *Thielaviopsis paradoxa* Mass. (Ascomycetes), *Schizophyllum commune* Fries (Basidiomycetes), and *Rhizopus* sp. (Phycomycetes).¹⁰ The first two are pathogenic on sugar cane, and although we can submit no direct evidence to incriminate the mealy bugs, their association with these fungi should be viewed with suspicion. The last two are merely saprophytic, growing probably on the sugary secretion of the mealy bugs and on the sap exuded by the cut ends of the sugar-cane stem.

CONTROL MEASURES

In view of the wide range of adaptability with respect to plant hosts belonging to the genus *Saccharum*, there is very little likelihood that much help may be secured from prospective development of resistant sugar cane varieties. *Trionymus sacchari* is prevalent on all sugar cane varieties, in almost any month of the year, quite irrespective of age of cane. There are certain cane varieties which show even more marked susceptibility to infestation than others, and the use of these should be avoided in any program in which control of this mealy bug is an important consideration.

Trionymus sacchari is attacked in the Philippines by a number of natural enemies, perhaps the most important among them being a species of *Aspergillus* which is apparently of cosmopolitan distribution. All the predatory enemies, such as the species of capsid bug, lady beetles, earwigs, and small cockroaches, and probably, at least in part, the parasitic wasps, discussed earlier in the present paper, are not specific to *Trionymus sacchari* but include other species of mealy bugs and possibly other insects which once were their original, indigenous prey. In view of the past attempts at introduction of beneficial insects into the Philippines, nearly all of which resulted in complete failure, and on account of the heavy expense involved in financing adequately conducted ventures of this kind, suggestion as to launching a program of biological control in connection with this particular insect pest is herein made advisedly. The wide geographical range of *Trionymus sacchari* has exposed this species to contact with autochthonous predators and parasites in the different countries where the pest has established itself. As more is known of the biology of this mealy bug in other countries, perhaps

¹⁰Identifications of fungi by Dr. G. O. Ocfemia.

promising beneficial forms may be discovered which, introduced into the Philippines, may help control not only *Trionymus sacchari* but certain other species as well.

In 1928, a species of lady beetles, *Cryptolaemus montrouzieri* Muls., originally a native of Australia, was brought into the Philippines from Hawaii, primarily for the control of *Trionymus sacchari*. Unfortunately, our experience with this species on the College Campus and elsewhere has been anything but encouraging. To be sure, they multiplied very rapidly in the insectary; at the present writing, we have several hundreds of living beetles and larvae in the cage. But from 1928 we have been periodically releasing the adults in the field so that to this date we have had a total of about three thousand that we set free at various places on the College Campus, at different points on Mount Maquiling up to about 1,000 meters elevation, in the town of Calamba and in Canlubang, and in addition, we shipped living beetles to Central Pilar, on Panay, and the P. S. A. entomological laboratory at La Carlota, Negros Occidental. The species, after these five years, has shown no signs of successful establishment. We have repeatedly observed that upon being set free from the cages, the adult beetles were frequently frustrated by the more aggressive ants whenever they tried to set foot on colonies of mealy bugs. Those that succeeded in laying eggs usually managed to rear one brood. There was one instance, however, in which we collected, on February 10, 1932, a single *Cryptolaemus* adult from the "variety nursery" of the College of Agriculture experiment station, which we were sure was the result of several generations from our last date of release, on April 7, 1931. Such rarity of field specimens recovered indicates that the species is barely managing to secure a dubious, and perhaps only temporary, foothold in our local biotic complex. A similar experience has apparently obtained in other Philippine localities.

Another possible handicap that has worked against *Cryptolaemus montrouzieri* in the Philippines is the highly accentuated seasonal fluctuations in available supply of food. The common, exposed *Ferrisia virgata*, for instance, which is seasonally the most abundant of our mealy bugs, are found thick on many plants on the College Campus for about three months in the year, during the summer, after which specimens can hardly be obtained. Likewise, the direct effect of some of the characteristic features of our climate, like the severe typhoons, probably works hardship on this lady beetle, which is apparently not so resourceful as most of our autochthonous coccinellid species.

One of the most prolific sources of *Trionymus* infestation in the sugarcane fields is the cane points, which ordinarily harbor mealy bugs underneath the leaf sheaths. Seed treatment with suitable insecticides will probably measurably reduce infestation.

Stubble and cut stems which are left in the field usually contain mealy bugs which remain viable for a long time. Burning trash on the field is not an effective means of killing these insects, since many of the individuals manage to survive. Hence, thorough preparation of the field by cleaning out and destroying the old stubble and cane parts should be practiced before planting.

The wild sugar cane, *Saccharum spontaneum* var. *indicum* is a prolific source of *Trionymus* infestation. Borders of fields, especially, should be cleaned as much as possible of this supplementary host.

Control of ants in the field to minimize dispersal of young mealy bugs would be a desirable means of reducing *Trionymus* infestation; devoid of protectors, the pests would be more freely accessible to the predators and parasites. The three species of ants which, as noted above, are the most assiduous caretakers of the mealy bugs live in the ground. Their nests may be destroyed in the field with comparatively little effort.

SUMMARY AND CONCLUSIONS

1. *Trionymus sacchari* (Cockerell) is widely distributed in the tropics of the world and also in a few countries north of the Tropic of Cancer and south of the Tropic of Capricorn.

2. On the basis of geographical distribution, a tentative deduction is made that the original home of the species was probably somewhere in the eastern half of Africa. The pest is probably of prehistoric introduction in the Philippines.

3. The principal host plants in the Philippines are *Saccharum officinarum* Linn., and *Saccharum spontaneum* Linn., subsp. *indicum* Hack. The insect is also found on *Andropogon halepensis* (L.) Brot. and *Oryza sativa* Linn.

4. In nearly all literature records for different countries, the host plant reported was sugar cane. In addition, a species of *Miscanthus* is a supplementary host in Formosa and rice is in India.

5. Certain morphological features of the female are discussed and a key for separation of female instars given.

6. The third antennal segment in the first, second, and third female nymphal instars, which bear six-segmented antennae, is apparently in a transitional state and eventually divides in the fourth and later instars, ultimately giving rise to the maximum number of segments in the adult. The adult female becomes seven or eight-segmented depending on the resulting number of daughter segments from this earlier third antennal segment.

7. The male adult and pupa are described.

8. *Trionymus sacchari* in the Philippines apparently has a strong tendency toward ovoviviparity, the young completing their development

in utero and issuing through the vaginal slit of the mother as "vermiform larvae," which shed their pellicles after an average of 28.7 ± 0.48 minutes.

9. Oviparity apparently occurs to a limited degree side by side with ovoviviparity, probably as a response to certain untoward environmental factors. The incubation period of the eggs is about three days.

10. Parthenogenesis is very common in this species and is apparently correlated with ovoviviparity.

11. The life cycle of the female was found to average 39.21 ± 0.43 days, with a coefficient of variation of 20.96 ± 0.78 per cent. There were six nymphal instars, the entire nymphal stage averaging 17.89 ± 0.15 days, with a coefficient of variation of 15.76 ± 0.59 per cent. The adult was able to live an average of 35.15 ± 0.62 days.

12. Reproduction began at an average of 20.54 ± 0.43 days after emergence, the coefficient of variation in this case being 40.07 ± 1.49 per cent. The number of young produced by a female averaged 200.81 ± 9.92 ; coefficient of variation, 54.87 ± 3.47 per cent. The mother died soon after the end of her period of fecundity, the average period of survival being only 1.54 ± 0.09 days, maximum 6 days; coefficient of variation 70.78 ± 4.47 per cent.

13. Dispersal of the insect apparently takes place largely in the first instar, but also in the second and third instars, with the ants aiding them in migrating to suitable hosts.

14. The males were rarely found, and in mothers where they were produced they constituted an average of only 8.76 ± 1.4 per cent of the total number of offspring.

15. The life span of the male from birth to emergence of adult averaged 21.03 ± 0.41 days. The nymphal stage, with five instars, occupied an average of 14.58 ± 0.3 days, and the pupal, 6.45 ± 0.28 days. The adult lived an average of only 3.87 ± 0.3 days.

16. Within the limits of mean monthly temperature ranges of from 26°C. to 30.5°C. , and average maxima of 29.1°C. to 35.9°C. , which prevailed during our periods of experiment, the curve for the length of nymphal stage tended to run parallel to that for temperature, while that for length of time from emergence of adult to first production of young took in general an adverse course.

17. A high relative humidity apparently exerted an important, although indirect, effect on life history and reproduction in that it served to temper the rigors of the higher temperatures, perhaps in the way of minimizing undue evaporation. The total duration of life cycle of the female during periods in which mean monthly relative humidity was below 80 per cent was 4.04 ± 0.586 days longer than in periods with mean monthly relative humidity above 80 per cent.

18. The most sensitive reactions as to changes in duration of nymphal stage occurred at prevailing temperatures of around 26°C., which was the lowest mean range obtained in the present work, and the least in the upper temperature limits. We interpret this condition as an indication that the optimum temperature for the development of the insect is around 26°C.

19. In comparison with years in which the monthly temperature ranges were lower and the amount of rainfall more, a high prevailing temperature with less rainfall during the year apparently considerably reduced cane infestation.

20. Rainfall had apparently a temporary effect on the degree of infestation, the downward fluctuation in percentage of infected stalks being evident only in the month immediately following a month with heavy precipitation.

21. Canes at all ages during the period of growth may apparently be infested with the same degree of severity.

22. No cane variety has been found to be markedly resistant to *Trionymus* infestation. Two varieties were found to be apparently much better liked by the insect than the others.

23. Four species of ants were observed to be especially helpful to the mealy bugs in that they protect them from enemies; three of these render additional service in carrying the young nymphs to fresh feeding grounds.

24. One species of fungus, one of cheese mites, three of parasitic Hymenoptera, four of coccinellid beetles, two of earwigs and at least one of dipterous larvae were found in the present work as natural enemies of *Trionymus sacchari*.

25. The introduced lady beetle, *Cryptolaemus montrouzieri* Muls., apparently has not been attended with marked success in the control of *Trionymus sacchari* or of any other form of mealy bugs. Factors responsible for the seeming failure of *Cryptolaemus* in the Philippines are analyzed.

26. Two species of fungi which are pathogenic on sugar cane have been noted in cultures as suspiciously associated with this mealy bug. These are *Melanconium sacchari* Mass. and *Thielaviopsis paradoxa* Mass.

27. The control measures recommended are insecticidal treatment of cane points, removal and disposal of old cane stubble and stems in field before replanting, cleaning out wild sugar cane from borders, and control of ants. Rice should not be used in rotation with sugar cane. Introduction of natural enemies from abroad is advisedly suggested as a possibility.

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TABLE 1

*Summary of life history of female Trionymus sacchari based on 164 cultures.
November, 1929 to May, 1931*

STAGES	DURATION	STANDARD DEVIATION	COEFFICIENT OF VARIATION
Vermiform larva	minutes	minutes	per cent
Maximum.....	41		
Minimum.....	20		
Average (40 larvae).....	28.7 ± 0.48	4.44 ± 0.497	15.47 ± 1.167
First stadium	days	days	per cent
Maximum.....	3		
Minimum.....	2		
Average.....	2.48 ± 0.02	0.49 ± 0.027	19.76 ± 0.736
Second stadium			
Maximum.....	4		
Minimum.....	2		
Average.....	2.90 ± 0.03	0.58 ± 0.032	20.00 ± 0.745
Third stadium			
Maximum.....	5		
Minimum.....	2		
Average.....	3.05 ± 0.03	0.65 ± 0.036	21.31 ± 0.794
Fourth stadium			
Maximum.....	6		
Minimum.....	2		
Average.....	3.26 ± 0.04	0.83 ± 0.046	25.46 ± 0.949
Fifth stadium			
Maximum.....	7		
Minimum.....	2		
Average.....	3.47 ± 0.05	0.97 ± 0.054	27.95 ± 1.042
Sixth stadium			
Maximum.....	7		
Minimum.....	2		
Average.....	3.71 ± 0.05	1.003 ± 0.055	27.04 ± 1.007
Nymphal stage			
Maximum.....	23		
Minimum.....	12		
Average.....	17.89 ± 0.15	2.82 ± 0.156	15.76 ± 0.587
Emergence of adult to first ap- pearance of young			
Maximum.....	44		
Minimum.....	8		
Average.....	20.54 ± 0.43	8.23 ± 0.455	40.07 ± 1.493
Life cycle			
Maximum.....	57		
Minimum.....	27		
Average.....	39.21 ± 0.43	8.22 ± 0.454	20.96 ± 0.781

TABLE 2

Summary of the life history of male Trionymus sacchari based on 31 cultures, September to December, 1929, February to July, 1930, and April to May, 1931

	DURATION	STANDARD DEVIATION	COEFFICIENT OF VARIATION
	days	days	per cent
First stadium			
Maximum.....	3		
Minimum.....	2		
Average.....	2.32 ± 0.05	0.46 ± 0.058	19.83 ± 1.700
Second stadium			
Maximum.....	4		
Minimum.....	2		
Average.....	2.70 ± 0.07	0.57 ± 0.072	21.10 ± 1.808
Third stadium			
Maximum.....	4		
Minimum.....	2		
Average.....	3.00 ± 0.28	2.31 ± 0.294	77.00 ± 6.599
Fourth stadium			
Maximum.....	5		
Minimum.....	2		
Average.....	2.80 ± 0.13	0.73 ± 0.093	26.07 ± 2.234
Fifth stadium			
Maximum.....	6		
Minimum.....	1		
Average.....	3.74 ± 0.18	1.52 ± 0.193	40.64 ± 3.483
Nymphal stage			
Maximum.....	19		
Minimum.....	9		
Average.....	14.58 ± 0.30	2.45 ± 0.311	16.80 ± 1.440
Pupal stage			
Maximum.....	11		
Minimum.....	3		
Average.....	6.45 ± 0.28	2.26 ± 0.287	35.04 ± 3.003
Longevity of adult			
Maximum.....	6		
Minimum.....	2		
Average.....	3.87 ± 0.32	1.26 ± 0.160	32.56 ± 2.790
Life span from birth to emergence of adult			
Maximum.....	28		
Minimum.....	14		
Average.....	21.03 ± 0.41	3.35 ± 0.426	5.93 ± 0.508

TABLE 3

Summary of reproduction in Trionymus sacchari, April to June, 1929, August to October, 1929 and February to October, 1930

	DURATION	STANDARD DEVIATION	COEFFICIENT OF VARIATION
	days	days	per cent
Period of fecundity, females			
Maximum.....	19		
Minimum.....	5		
Average (57 individuals)....	12.29 ± 0.30	3.30 ± 0.309	2.69 ± 0.170
Longevity of adult female			
Maximum.....	50		
Minimum.....	25		
Average (57 individuals)....	35.15 ± 0.62	6.93 ± 0.649	19.70 ± 1.245
Number of days female survives period of fecundity			
Maximum.....	6		
Minimum.....	1		
Average (57 individuals)....	1.54 ± 0.09	1.09 ± 0.102	70.78 ± 4.474
Number of young produced by a female			
Maximum.....	593		
Minimum.....	48		
Average (57 individuals)....	200.81 ± 9.92	110.20 ± 10.328	54.87 ± 3.469
Number of young in sets where males developed (September, 1929, only)			
Maximum.....	138		
Minimum.....	68		
Average (10 cultures).....	101.50 ± 4.45	19.85 ± 4.441	19.56 ± 2.952
Number of males developing from each set (September, 1929, only)			
Maximum.....	29		
Minimum.....	2		
Average (10 cultures).....	9.60 ± 1.92	8.55 ± 1.912	89.06 ± 13.439
Proportion of males to total number of offspring (Sep- tember 1929, only)			
Maximum, per cent.....	21.64		
Minimum, per cent.....	1.85		
Average (10 cultures, percent)	8.76 ± 1.42	6.32 ± 1.414	72.15 ± 10.886

TABLE 4

Potted sugar cane method
based on cultures No. 160, 163, 171, and 172. January to February, 1931

STAGES	AVERAGES	STANDARD DEVIATION	COEFFICIENT OF VARIATION
	<i>days</i>	<i>days</i>	<i>per cent</i>
First stadium.....	2.00±0.00	0.00±0.000	00.00±0.000
Second stadium.....	3.50±0.19	0.50±0.177	14.28±3.416
Third stadium.....	3.25±0.17	0.43±0.152	13.23±3.164
Fourth stadium.....	4.25±0.17	0.43±0.152	10.11±2.418
Fifth stadium.....	3.50±0.19	0.50±0.177	14.29±3.417
Sixth stadium.....	4.50±0.34	0.86±0.305	19.11±4.571
Nymphal stage.....	22.00±0.61	1.58±0.560	7.18±1.717
Emergence of adult to first appearance of young.....	20.25±0.42	1.08±0.383	5.33±1.275
Life cycle.....	41.25±0.32	0.79±0.280	1.92±0.458

Potted sugar cane method
based on cultures No. 180, 185, 190, and 195. April to May, 1931

First stadium.....	2.25±0.17	0.43±0.152	19.11±4.571
Second stadium.....	2.75±0.17	0.43±0.152	15.64±3.740
Third stadium.....	2.75±0.32	0.82±0.291	29.82±7.132
Fourth stadium.....	2.50±0.19	0.50±0.177	20.00±4.784
Fifth stadium.....	3.25±0.51	1.29±0.457	39.69±9.493
Sixth stadium.....	3.50±0.19	0.50±0.177	14.28±3.416
Nymphal stage.....	17.00±0.00	0.00±0.000	0.00±0.000
Emergence of adult to first appearance of young.....	15.00±0.27	0.70±0.248	4.67±1.116
Life cycle.....	32.00±0.27	0.70±0.248	2.19±0.523

Battery jar method
based on cultures No. 135, 136, 137, 138, 139, and 140. January to February, 1931

First stadium.....	2.00±0.00	0.00±0.000	0.00±0.000
Second stadium.....	2.30±0.14	0.47±0.136	20.43±3.983
Third stadium.....	3.00±0.17	0.57±0.165	19.00±3.704
Fourth stadium.....	4.30±0.22	0.74±0.214	17.20±3.353
Fifth stadium.....	4.16±0.27	0.89±0.257	21.39±4.141
Sixth stadium.....	4.30±0.37	1.24±0.370	28.83±5.620
Nymphal stage.....	20.16±0.59	1.95±0.564	9.67±1.885
Emergence of adult to first appearance of young.....	19.80±1.21	4.01±1.159	20.35±3.967
Life cycle.....	40.00±0.76	2.51±0.725	6.27±1.222

Battery jar method
based on cultures No. 156, 157, 158, and 159. April to May, 1931

First stadium.....	2.00±0.00	0.00±0.000	0.00±0.000
Second stadium.....	2.75±0.17	0.43±0.152	15.63±3.738
Third stadium.....	2.50±0.19	0.50±0.177	20.00±4.784
Fourth stadium.....	2.25±0.17	0.43±0.152	19.11±4.571
Fifth stadium.....	3.25±0.51	1.29±0.457	39.69±9.493
Sixth stadium.....	3.75±0.32	0.82±0.291	21.87±5.230
Nymphal stage.....	16.50±0.19	0.50±0.177	30.30±7.247
Emergence of adult to first appearance of young.....	14.25±1.01	2.86±1.014	20.07±4.800
Life cycle.....	30.75±1.01	2.50±0.887	8.13±1.945

TABLE 5

Comparison of potted and battery-jar method, January to February, 1931

	DIFFERENCE (POT- TED LESS BATTERY. JAR METHOD)
	<i>days</i>
First stadium.....(0.00 - 0.00)....	0.00±0.000
Second stadium.....(3.50 - 2.30)....	1.20±0.296
Third stadium.....(3.25 - 3.00)....	0.25±0.238
Fourth stadium.....(4.25 - 4.30)....	-0.05±0.279
Fifth stadium.....(3.50 - 4.16)....	-0.66±0.329
Sixth stadium.....(4.50 - 4.30)....	0.20±0.491
Nymphal stage.....(22.00 -20.16)....	1.84±0.849
Emergence of adult to first appearance of young....(20.25 -19.80)....	0.45±1.277
Life cycle.....(41.25 -40.00)....	1.25±0.819

Comparison of potted and battery-jar methods, April to May, 1931

	DIFFERENCE (POT- TED LESS BATTERY. JAR METHOD)
	<i>days</i>
First stadium.....(2.25 - 2.00)....	0.25±0.169
Second stadium.....(2.75 - 2.75)....	0.00±0.216
Third stadium.....(2.75 - 2.50)....	0.25±0.369
Fourth stadium.....(2.50 - 2.25)....	0.25±0.253
Fifth stadium.....(3.25 - 3.25)....	0.00±0.715
Sixth stadium.....(3.50 - 3.75)....	-0.25±0.369
Nymphal stage.....(17.00 -16.50)....	0.50±0.189
Emergence of adult to first appearance of young....(15.00 -14.25)....	0.75±1.047
Life cycle.....(32.00 -30.75)....	1.25±1.047

TABLE 6

Effect of season on the life history of Trionymus sacchari

DATES	NUMBER OF CULTURES	FIRST STADIUM	SECOND STADIUM	THIRD STADIUM	FOURTH STADIUM
		days	days	days	days
26-XII-1929 to 21- II-1930	6	2.16±0.11	3.00±0.24	2.50±0.15	2.50±0.15
29-XII-1929 to 20- II-1930	4	2.25±0.17	2.25±0.17	2.00±0.00	2.00±0.00
30-XII-1929 to 18- II-1930	7	2.28±0.12	2.28±0.12	2.28±0.12	3.00±0.00
11- II-1930 to 1- IV-1930	4	2.00±0.00	2.00±0.00	3.00±0.00	3.00±0.00
1- IV-1930 to 5- V-1930	7	2.00±0.00	3.00±0.00	3.00±0.00	4.00±0.14
23- V-1930 to 28- VI-1930	5	3.00±0.00	3.00±0.00	3.40±0.16	3.80±0.16
27- V-1930 to 17-VII-1930	4	3.00±0.00	4.00±0.00	4.00±0.00	3.00±0.00
30-VII-1930 to 3- IX-1930	4	3.00±0.00	3.00±0.00	3.75±0.17	2.75±0.17
17- IV-1931 to 21- V-1931	4	2.00±0.00	3.00±0.00	2.75±0.17	2.50±0.61
10-VIII-1930 to 11-IX-1930	2	3.00±0.00	3.00±0.00	3.00±0.00	3.50±0.34
31-VIII-1930 to 3- X-1930	2	3.00±0.00	3.00±0.00	4.50±0.34	4.00±0.00

TABLE 6—(continued)

Effect of season on the life history of Trionymus sacchari

DATES	NUMBER OF CULTURES	FIFTH STADIUM	SIXTH STADIUM	NYMPHAL STAGE	EMERGENCE OF ADULT TO FIRST APPEARANCE OF YOUNG	LIFE CYCLE
		days	days	days	days	days
26-XII-1929 to 21- II-1930	6	2.66±0.14	3.00±0.17	15.83±0.74	37.33±2.06	53.66±
29-XII-1929 to 20- II-1930	4	2.00±0.00	2.75±0.51	13.25±0.84	34.25±2.45	47.50±
30-XII-1929 to 18- II-1930	7	3.00±0.25	3.00±0.36	15.59±0.96	31.42±0.82	47.00±
11- II-1930 to 1- IV-1930	4	2.75±0.17	3.00±0.00	15.75±0.17	28.25±1.36	44.00±
1- IV-1930 to 5- V-1930	7	4.42±0.14	3.28±0.12	19.70±0.19	11.57±0.24	31.28±
23- V-1930 to 28- VI-1930	5	3.40±0.16	5.00±0.21	21.60±0.27	14.20±0.32	35.80±
27- V-1930 to 17-VII-1930	4	3.00±0.00	3.00±0.00	20.00±0.00	19.00±3.10	39.00±
30-VII-1930 to 3- IX-1930	4	3.50±0.34	4.75±0.17	20.75±0.57	14.00±0.61	34.75±
17- IV-1931 to 21- V-1931	4	5.00±0.68	4.75±0.17	18.50±0.61	14.50±0.58	33.00±
10-VIII-1930 to 11-IX-1930	2	4.00±0.00	6.00±0.68	22.50±0.34	8.50±0.34	31.00±
31-VIII-1930 to 3- X-1930	2	3.50±0.34	3.50±0.34	21.50±0.34	10.50±1.01	32.00±

TABLE 7

Weather records at the College of Agriculture, 1928, 1929, 1930, and 1931

MONTHS	TEMPERATURE			RAINFALL		MEAN MONTHLY RELATIVE HUMIDITY
	Average maximum	Average minimum	Monthly mean	Amount	Number of days	
<i>1928</i>	°C.	°C.	°C.	mm.		<i>per cent</i>
January.....	28.9	23.6	26.2	195.8	17	No record avail- able
February.....	29.5	24.0	26.8	91.8	13	
March.....	31.6	23.6	27.6	5.1	3	
April.....	32.0	25.1	28.5	171.5	10	
May.....	32.7	25.8	29.2	73.9	10	
June.....	30.9	25.5	28.2	99.7	17	
July.....	30.9	25.4	28.2	263.8	27	
August.....	30.2	25.1	27.7	54.9	12	
September.....	30.2	24.9	27.6	165.6	21	
October.....	30.7	25.0	27.9	113.8	15	
November.....	30.4	24.5	27.4	185.1	15	
December.....	29.6	24.3	26.9	70.2	18	
<i>1929</i>						
January.....	28.0	23.3	25.7	108.8	18	72.9
February.....	29.6	24.0	26.8	12.4	5	75.0
March.....	31.0	24.9	28.0	28.1	6	79.5
April.....	32.4	25.0	28.7	18.4	5	78.8
May.....	33.6	25.1	29.3	47.1	9	84.4
June.....	32.9	25.2	29.0	155.8	7	85.9
July.....	31.1	24.7	27.9	399.0	17	84.5
August.....	31.2	24.2	27.7	261.2	14	84.7
September.....	32.2	23.8	28.0	356.5	10	80.1
October.....	30.8	24.6	27.7	342.9	21	74.1
November.....	28.9	24.7	26.8	250.2	22	65.3
December.....	29.1	23.4	26.3	116.5	18	65.3
<i>1930</i>						
January.....	29.1	23.0	26.0	40.8	5	58.4
February.....	29.9	23.3	26.6	3.9	4	56.6
March.....	32.8	24.6	28.7	20.9	2	62.5
April.....	32.2	24.7	28.5	65.5	11	52.4
May.....	31.5	25.9	28.7	281.1	15	61.7
June.....	31.3	25.8	28.6	269.3	17	61.1
July.....	30.8	26.1	28.5	360.4	16	57.7
August.....	30.9	25.5	28.2	275.0	21	66.4
September.....	31.1	25.3	28.2	272.5	13	80.6
October.....	30.8	25.5	28.6	226.1	10	85.4
November.....	29.6	25.3	27.4	449.7	16	86.1
December.....	29.3	24.8	27.0	240.4	13	86.5
<i>1931</i>						
January.....	29.9	24.4	27.1	10.8	6	89.0
February.....	32.0	24.1	28.0	3.1	1	83.8
March.....	34.4	24.6	29.5	16.5	2	84.5
April.....	35.9	24.9	30.5	104.5	6	84.4
May.....	36.0	25.4	30.5	103.7	9	87.3
June.....	33.9	26.2	30.1	119.7	17	88.9
July.....	32.4	25.5	28.9	183.1	22	88.6
August.....	31.4	25.6	28.7	296.9	21	91.1
September.....	32.1	26.8	28.8	287.1	15	89.1
October.....	31.6	25.4	28.9	228.5	17	88.6
November.....	31.0	24.3	27.5	223.9	14	89.2
December.....	30.1	24.9	27.5	148.4	10	87.1

TABLE 8

Weather records at Canlubang, 1928 and 1929

MONTHS	TEMPERATURE			RAINFALL	
	Average maximum	Average minimum	Monthly mean	Amount	Number of days
<i>1928</i>	°C.	°C.	°C.	mm.	
January.....	29.42	21.28	25.35	181.20	14
February.....	29.96	21.25	25.61	1.95	12
March.....	31.79	21.51	26.65	3.56	5
April.....	33.45	22.69	28.07	42.93	4
May.....	32.00	23.30	28.20	306.96	18
June.....	30.80	22.90	26.80	303.60	18
July.....	30.40	22.80	26.60	278.37	22
August.....	32.10	22.80	27.50	144.71	9
September....	29.40 •	22.60	26.00	369.92	23
October.....	30.00	22.10	26.10	115.57	15
November....	29.80	21.90	25.80	182.63	14
December....	28.50	21.10	24.80	76.20	16
<i>1929</i>					
January.....	27.80	20.00	25.30	74.93	13
February.....	29.90	20.80	25.30	5.84	4
March.....	30.90	21.20	26.10	6.35	4
April.....	33.00	22.50	27.70	61.72	6
May.....	32.90	23.00	28.00	255.02	15
June.....	32.10	23.10	27.60	101.85	17
July.....	29.60	22.50	26.00	628.90	28
August.....	29.90	22.10	26.00	297.69	24
September....	30.30	22.30	26.30	538.15	19
October.....	29.30	21.90	25.60	270.51	20
November....	29.20	21.80	25.50	156.72	18
December....	28.50	20.40	24.40	121.41	15

TABLE 9

Relation of length of nymphal stage to climatic factors. Based on tables 6 and 7

DURATION OF NYMPHAL STAGE	MONTH	TEMPERATURE		MEAN MONTHLY RELATIVE HUMIDITY
		Average maximum	Monthly mean	
<i>days</i>		<i>°C.</i>	<i>°C.</i>	<i>per cent</i>
14.89	Jan. 1930	29.1	26.0	58.4
15.75	Feb. 1930	29.9	26.6	56.6
18.50	April 1931	35.9	30.5	84.4
19.70	April 1930	32.2	28.5	52.4
21.30	June 1930	31.3	28.6	61.1
21.50	Sept. 1930	31.1	28.2	80.6
21.63	Aug. 1930	30.9	28.2	66.4

TABLE 10

Relation of duration of period from emergence of adult to production of first young to climatic factors. Based on tables 6 and 7

DURATION OF PERIOD	MONTH	TEMPERATURE		MEAN MONTHLY RELATIVE HUMIDITY
		Average maximum	Monthly mean	
<i>days</i>		<i>°C.</i>	<i>°C.</i>	<i>per cent</i>
9.75	Sept. 1930	31.1	28.2	80.6
11.57	April 1930	32.2	28.5	52.4
14.00	Aug. 1930	30.9	28.2	66.4
14.50	May 1931	36.0	30.5	27.3
16.60	June 1930	31.3	28.6	61.1
28.25	March 1930	32.8	28.7	62.5
34.33	Jan. 1930	29.1	26.0	58.4

TABLE 11

Summary of life history of female Trionymus sacchari during periods with mean monthly relative humidity of above 80 per cent: July to August, 1929; September to December, 1930; January to May, 1931. Based on 54 cultures

STAGES	DURATION	STANDARD DEVIATION	COEFFICIENT OF VARIATION
	days	days	per cent
First stadium			
Maximum.....	3		
Minimum.....	2		
Average.....	2.25 ± 0.040	0.43 ± 0.041	19.11 ± 1.241
Second stadium			
Maximum.....	4		
Minimum.....	2		
Average.....	2.85 ± 0.054	0.59 ± 0.057	20.70 ± 1.343
Third stadium			
Maximum.....	5		
Minimum.....	2		
Average.....	3.07 ± 0.061	0.65 ± 0.063	21.17 ± 1.374
Fourth stadium			
Maximum.....	5		
Minimum.....	2		
Average.....	3.18 ± 0.081	0.88 ± 0.085	27.67 ± 1.796
Fifth stadium			
Maximum.....	5		
Minimum.....	2		
Average.....	3.50 ± 0.081	0.89 ± 0.086	25.42 ± 1.650
Sixth stadium			
Maximum.....	6		
Minimum.....	2		
Average.....	3.72 ± 0.088	0.98 ± 0.094	26.34 ± 1.710
Nymphal stage			
Maximum.....	23		
Minimum.....	14		
Average.....	18.59 ± 0.196	2.13 ± 0.205	11.45 ± 0.743
Adult at first appearance of young			
Maximum.....	29		
Minimum.....	9		
Average.....	18.12 ± 0.418	4.81 ± 0.462	26.54 ± 1.723
Life cycle			
Maximum.....	43		
Minimum.....	27		
Average.....	36.72 ± 0.411	4.77 ± 0.459	12.99 ± 0.843

TABLE 12

Summary of life history of female Trionymus sacchari during periods with mean monthly relative humidity of below 80 per cent: November to December, 1929; January to August, 1930.

Based on 108 cultures

STAGES	DURATION	STANDARD DEVIATION	COEFFICIENT OF VARIATION
	<i>days</i>	<i>days</i>	<i>per cent</i>
First stadium			
Maximum.....	3		
Minimum.....	2		
Average.....	2.60 ± 0.029	0.48 ± 0.032	18.46 ± 0.848
Second stadium			
Maximum.....	4		
Minimum.....	2		
Average.....	2.89 ± 0.034	0.59 ± 0.040	20.41 ± 0.937
Third stadium			
Maximum.....	5		
Minimum.....	2		
Average.....	3.05 ± 0.040	0.69 ± 0.047	22.62 ± 1.039
Fourth stadium			
Maximum.....	6		
Minimum.....	2		
Average.....	3.31 ± 0.047	0.80 ± 0.054	24.16 ± 1.109
Fifth stadium			
Maximum.....	7		
Minimum.....	2		
Average.....	3.45 ± 0.061	1.02 ± 0.069	29.56 ± 1.357
Sixth stadium			
Maximum.....	7		
Minimum.....	2		
Average.....	3.70 ± 0.067	1.03 ± 0.070	27.83 ± 1.285
Nymphal stage			
Maximum.....	23		
Minimum.....	12		
Average.....	19.02 ± 0.135	2.76 ± 0.187	14.51 ± 0.666
Adult at first appearance of young			
Maximum.....	44		
Minimum.....	8		
Average.....	21.90 ± 0.587	9.08 ± 0.618	41.46 ± 1.903
Life cycle			
Maximum.....	57		
Minimum.....	29		
Average.....	40.76 ± 0.418	8.48 ± 0.577	20.80 ± 0.955

TABLE 13

Comparison of different events in tables 11 and 12

STAGES	DIFFERENCES OF AVERAGES ^a
	<i>days</i>
First stadium.....(2.60 - 2.25).....	0.35±0.049
Second stadium.....(2.89 - 2.85).....	0.04±0.063
Third stadium.....(3.05 - 3.07).....	-0.02±0.072
Fourth stadium.....(3.31 - 3.18).....	0.13±0.093
Fifth stadium.....(3.45 - 3.50).....	-0.05±0.101
Sixth stadium.....(3.70 - 3.72).....	-0.02±0.110
Nymphal stage.....(19.02 -18.59).....	0.43±0.237
Emergence of adult to first appearance of young.....(21.90 -18.12).....	0.78±0.720
Life cycle.....(40.76 -36.72).....	4.04±0.586

^aEvents in periods with mean monthly relative humidity below 80 per cent, less corresponding events in periods with mean monthly relative humidity above 80 per cent.

TABLE 14

*Seasonal range of infestation of twelve sugar cane varieties at Canlubang, Laguna,
from September, 1928 to October, 1929*

DATE	AGE OF PLANT CANES	STALKS INFESTED	STANDARD DEVIATION	COEFFICIENT OF VARIATION
<i>1928</i>	<i>months</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>
17 to 28-IX.....	8	3.28±0.627	0.89±0.199	0.27±0.041
15 to 22-X.....	9	5.32±0.748	3.38±0.755	0.64±0.096
<i>1929</i>				
10 to 18-IV.....	4	59.35±2.523	11.80±2.516	0.20±0.029
17 to 20-V.....	4-6	44.93±2.637	3.61±0.808	0.08±0.012
12 to 20-VI.....	6	41.71±2.044	9.10±2.035	0.22±0.033
24 to 30-VI.....	6	50.78±1.376	6.13±1.371	0.12±0.018
24 to 26-VII.....	7	41.58±1.848	8.22±1.839	0.20±0.030
1 to 7-VII.....	7	49.68±2.104	8.84±2.084	0.18±0.028
21 to 24-VIII.....	8	38.74±2.428	10.78±2.412	0.28±0.042
11 to 14-VIII.....	8	47.75±3.217	13.48±3.179	0.28±0.045
16 to 25-IX.....	9	49.15±0.668	2.99±0.668	0.06±0.009
18 to 26-X.....	10	28.90±1.895	8.44±0.292	0.29±0.044

Varieties included are listed in table 15.

TABLE 14a
*Monthly percentage of infestation at Canlubang.
 Computed from table 14*

DATES	AGE OF CANES	STALKS INFESTED
<i>1928</i>	<i>months</i>	<i>per cent</i>
September.....	8	3.28
October.....	9	5.52
<i>1929</i>		
April.....	4	59.35
May.....	4-6	44.93
June.....	6	46.25
July.....	7	45.63
August.....	8	43.25
September.....	9	49.15
October.....	10	28.90

TABLE 15

Relative susceptibility of different sugar-cane varieties to Trionymus sacchari (Ckll.). (Percentages of stalks infested.)^a

VARIETY	STALKS INFESTED	STANDARD DEVIATION	COEFFICIENT OF VARIATION
	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>
2727 P. O. J.....	53.95 ± 6.35	13.32 ± 5.459	0.25 ± 0.068
2714 P. O. J.....	51.45 ± 8.48	17.78 ± 7.287	0.35 ± 0.096
Mauritius 1900.....	41.95 ± 3.50	17.22 ± 3.521	0.41 ± 0.053
C. A. C. 111.....	41.18 ± 3.37	16.50 ± 3.374	0.40 ± 0.056
Luzon White.....	39.86 ± 3.64	17.89 ± 3.658	0.45 ± 0.062
Hawaii 109.....	38.82 ± 3.82	18.79 ± 3.843	0.48 ± 0.067
New Guinea 24-A.....	38.28 ± 3.19	15.68 ± 3.207	0.41 ± 0.056
Malagache.....	38.18 ± 4.82	21.40 ± 4.787	0.56 ± 0.085
Pampanga Red.....	37.92 ± 4.31	21.19 ± 4.476	0.56 ± 0.077
Cebu Purple.....	37.48 ± 2.60	12.79 ± 2.616	0.34 ± 0.047
Badila 147.....	34.81 ± 4.86	21.80 ± 4.877	0.63 ± 0.094
C. A. C. 87.....	29.24 ± 4.80	20.16 ± 4.755	0.69 ± 0.110

^aResults of twelve inspections at different times at Canlubang, Laguna, from September, 1928, to October, 1929, by Mr. Catalino T. Buligan. Fifty hills considered in each inspection; every plant in each hill examined carefully. Intervals between inspections about one month.

TABLE 16

Summary of comparison of susceptibility of different varieties with Cebu Purple as standard. Based on table 15

VARIETIES	DIFFERENCES
	<i>per cent</i>
2727 P. O. J.....	+16.50 ± 6.864
2714 P. O. J.....	+13.97 ± 8.754
Mauritius 1900.....	+ 4.47 ± 4.343
C. A. C. 111.....	+ 3.70 ± 4.251
Luzon White.....	+ 2.38 ± 4.468
Hawaii 109.....	+ 1.34 ± 4.617
New Guinea 24-A.....	+ 0.80 ± 4.112
Malagache.....	+ 0.70 ± 5.477
Pampanga Red.....	+ 0.44 ± 5.031
Badila 147.....	- 2.67 ± 5.506
C. A. C. 87.....	- 8.24 ± 5.460

TABLE 17

Total lengths of antennae of different instars of Trionymus sacchari
(each item based on 40 individuals)

	LENGTH	STANDARD DEVIATION	COEFFICIENT OF VARIATION
	<i>mm.</i>	<i>mm.</i>	<i>per cent</i>
First instar			
Maximum.....	0.20		
Minimum.....	0.18		
Average.....	0.18 ± 0.0007	0.009 ± 0.00001	5.00 ± 0.377
Second instar			
Maximum.....	0.24		
Minimum.....	0.17		
Average.....	0.19 ± 0.0016	0.014 ± 0.00160	7.36 ± 0.061
Third instar			
Maximum.....	0.26		
Minimum.....	0.16		
Average.....	0.20 ± 0.0024	0.022 ± 0.00002	1.10 ± 0.083
Fourth instar			
Maximum.....	0.34		
Minimum.....	0.19		
Average.....	0.26 ± 0.0040	0.037 ± 0.00410	14.23 ± 1.074
Fifth instar			
Maximum.....	0.35		
Minimum.....	0.20		
Average.....	0.24 ± 0.0034	0.031 ± 0.00350	12.90 ± 0.973
Sixth instar			
Maximum.....	0.36		
Minimum.....	0.26		
Average.....	0.32 ± 0.0034	0.036 ± 0.00400	11.25 ± 0.849
Newly emerged adult			
Maximum.....	0.36		
Minimum.....	0.31		
Average.....	0.33 ± 0.0016	0.016 ± 0.00180	4.84 ± 0.365
Adult at first appearance of young			
Maximum.....	0.37		
Minimum.....	0.29		
Average.....	0.33 ± 0.0024	0.022 ± 0.00250	6.66 ± 0.502
Adult male			
Maximum.....	0.53		
Minimum.....	0.38		
Average.....	0.45 ± 0.0034	0.033 ± 0.00360	7.33 ± 0.553

TABLE 19

Measurements of body, femora, and tibiae in different stages of Trionymus sacchari (each item based on 40 individuals)

STAGES	BODY					
	Length	Standard deviation	Coefficient of variation	Width	Standard deviation	Coefficient of variation
	<i>mm.</i>	<i>mm.</i>	<i>per cent</i>	<i>mm.</i>	<i>mm.</i>	<i>per cent</i>
First instar						
Maximum.....	0.63			0.39		
Minimum.....	0.40			0.12		
Average.....	0.54 ± 0.005	0.044 ± 0.0049	0.898 ± 0.068	0.22 ± 0.0034	0.032 ± 0.0035	1.578 ± 0.119
Second instar						
Maximum.....	0.92			0.51		
Minimum.....	0.60			0.26		
Average.....	0.73 ± 0.007	0.070 ± 0.0078	1.071 ± 0.081	0.33 ± 0.0061	0.050 ± 0.0056	1.673 ± 0.126
Third instar						
Maximum.....	1.43			0.71		
Minimum.....	0.81			0.32		
Average.....	0.99 ± 0.002	0.171 ± 0.0191	0.912 ± 0.069	0.44 ± 0.0067	0.110 ± 0.0123	2.776 ± 0.209
Fourth instar						
Maximum.....	1.87			0.99		
Minimum.....	0.90			0.35		
Average.....	1.38 ± 0.027	0.280 ± 0.0313	2.268 ± 0.171	0.65 ± 0.0196	0.180 ± 0.0201	3.090 ± 0.233
Fifth instar						
Maximum.....	2.46			1.15		
Minimum.....	0.97			0.51		
Average.....	1.55 ± 0.061	0.567 ± 0.0634	4.100 ± 0.309	0.76 ± 0.0202	0.207 ± 0.0232	3.046 ± 0.230
Sixth instar						
Maximum.....	2.50			1.22		
Minimum.....	1.33			0.78		
Average.....	1.98 ± 0.028	0.260 ± 0.0290	1.464 ± 0.110	1.01 ± 0.0108	0.101 ± 0.0112	1.110 ± 0.084
Newly emerged adult						
Maximum.....	3.45			1.80		
Minimum.....	1.46			0.78		
Average.....	2.25 ± 0.041	0.442 ± 0.0494	2.200 ± 0.165	1.16 ± 0.0236	0.224 ± 0.0250	2.140 ± 0.016
Female adult at first appearance of young (balsam mount from cultures)						
Maximum.....	3.43			2.18		
Minimum.....	2.38			1.39		
Average.....	2.90 ± 0.031	0.290 ± 0.0324	1.11 ± 0.084	1.75 ± 0.0202	0.190 ± 0.0212	1.211 ± 0.091
Female adult at first appearance of young (fresh specimens from field)						
Maximum.....	4.93			2.72		
Minimum.....	3.16			1.66		
Average (50 individuals).....	3.96 ± 0.035	0.368 ± 0.0368	0.920 ± 0.062	2.13 ± 0.0236	0.249 ± 0.0249	1.171 ± 0.079
Male adult						
Maximum.....	1.47			0.35		
Minimum.....	0.80			0.24		
Average.....	1.05 ± 0.017	0.160 ± 0.0178	16.95 ± 1.279	0.30 ± 0.0037	0.035 ± 0.0039	1.292 ± 0.097
Male pupa						
Maximum.....	1.30			0.42		
Minimum.....	0.81			0.19		
Average.....	1.08 ± 0.009	0.090 ± 0.0100	0.92 ± 0.069	0.36 ± 0.0041	0.044 ± 0.0500	1.370 ± 0.103

TABLE 19—(Continued)

Measurements of body, femora, and tibiae in different stages of *Trionymus sacchari* (each item based on 40 individuals)

STAGES	FORE LEG					
	FEMUR			TIBIA		
	Length	Standard deviation	Coefficient of variation	Length	Standard deviation	Coefficient of variation
	mm.	mm.	per cent	mm.	mm.	per cent
First instar						
Maximum	0.084			0.059		
Minimum	0.063			0.042		
Average	0.076 ± 0.001	0.029 ± 0.0030	4.276 ± 0.323	0.049 ± 0.001	0.005 ± 0.0010	1.10 ± 0.083
Second instar						
Maximum	0.101			0.067		
Minimum	0.059			0.034		
Average	0.078 ± 0.001	0.010 ± 0.0010	1.384 ± 0.104	0.053 ± 0.001	0.009 ± 0.0010	1.83 ± 0.014
Third instar						
Maximum	0.101			0.084		
Minimum	0.067			0.042		
Average	0.084 ± 0.002	0.014 ± 0.0016	1.916 ± 0.145	0.055 ± 0.004	0.011 ± 0.0013	2.27 ± 0.171
Fourth instar						
Maximum	0.143			0.101		
Minimum	0.084			0.051		
Average	0.117 ± 0.002	0.016 ± 0.0018	1.521 ± 0.115	0.087 ± 0.001	0.014 ± 0.0015	1.77 ± 0.134
Fifth instar						
Maximum	0.126			0.126		
Minimum	0.055			0.055		
Average	0.122 ± 0.003	0.032 ± 0.0035	2.901 ± 0.219	0.085 ± 0.003	0.026 ± 0.0029	3.35 ± 0.253
Sixth instar						
Maximum	0.194			0.126		
Minimum	0.110			0.059		
Average	0.138 ± 0.003	0.024 ± 0.0027	1.942 ± 0.147	0.097 ± 0.002	0.017 ± 0.0019	1.97 ± 0.149
Newly emerged adult						
Maximum	0.185			0.143		
Minimum	0.110			0.076		
Average	0.153 ± 0.002	0.019 ± 0.0022	1.418 ± 0.107	0.112 ± 0.002	0.018 ± 0.0020	1.75 ± 0.132
Female adult at first appearance of young (balsam mount from cultures)						
Maximum	0.203			0.152		
Minimum	0.126			0.105		
Average	0.165 ± 0.002	0.015 ± 0.0017	1.012 ± 0.076	0.124 ± 0.001	0.037 ± 0.0041	3.32 ± 0.251
Female adult at first appearance of young (fresh specimens from field)						
Maximum	—	—	—	—	—	—
Minimum	—	—	—	—	—	—
Average (50 individuals)	—	—	—	—	—	—
Male adult						
Maximum	0.177			0.168		
Minimum	0.122			0.122		
Average	0.147 ± 0.001	0.010 ± 0.0012	0.782 ± 0.059	0.150 ± 0.001	0.011 ± 0.0012	0.79 ± 0.598
Male pupa						
Maximum	—	—	—	—	—	—
Minimum	—	—	—	—	—	—
Average	—	—	—	—	—	—

TABLE 19—(Continued)

Measurements of body, femora, and tibiae in different stages of *Trionymus sacchari* (each item base on 40 individuals)

STAGES	MIDDLE LEG					
	FEMUR			TIBIA		
	Length	Standard deviation	Coefficient of variation	Length	Standard deviation	Coefficient of variation
	mm.	mm.	per cent	mm.	mm.	per cent
First instar						
Maximum.....	0.092			0.059		
Minimum.....	0.067			0.042		
Average.....	0.077 \pm 0.0010	0.007 \pm 0.001	1.064 \pm 0.080	0.052 \pm 0.001	0.006 \pm 0.0006	1.182 \pm 0.089
Second instar						
Maximum.....	0.084			0.071		
Minimum.....	0.067			0.042		
Average.....	0.080 \pm 0.0007	0.006 \pm 0.007	9.025 \pm 0.681	0.057 \pm 0.001	0.009 \pm 0.0010	1.719 \pm 0.130
Third instar						
Maximum.....	0.135			0.101		
Minimum.....	0.046			0.046		
Average.....	0.088 \pm 0.0014	0.014 \pm 0.002	1.727 \pm 0.130	0.062 \pm 0.001	0.011 \pm 0.0013	2.032 \pm 0.153
Fourth instar						
Maximum.....	0.169			0.110		
Minimum.....	0.084			0.059		
Average.....	0.125 \pm 0.0019	0.018 \pm 0.002	1.560 \pm 0.118	0.092 \pm 0.002	0.015 \pm 0.0017	1.790 \pm 0.135
Fifth instar						
Maximum.....	0.202			0.143		
Minimum.....	0.084			0.059		
Average.....	0.134 \pm 0.0038	0.036 \pm 0.004	2.970 \pm 0.224	0.097 \pm 0.003	0.029 \pm 0.0033	2.319 \pm 0.175
Sixth instar						
Maximum.....	0.211			0.169		
Minimum.....	0.101			0.059		
Average.....	0.151 \pm 0.0030	0.028 \pm 0.003	2.046 \pm 0.154	0.114 \pm 0.002	0.024 \pm 0.0026	2.298 \pm 0.173
Newly emerged adult						
Maximum.....	0.202			0.160		
Minimum.....	0.110			0.076		
Average.....	0.163 \pm 0.0026	0.024 \pm 0.003	1.625 \pm 0.123	0.127 \pm 0.002	0.021 \pm 0.0023	1.803 \pm 0.136
Female adult at first appearance of young (balsam mount from cultures)						
Maximum.....	0.219			0.177		
Minimum.....	0.135			0.110		
Average.....	0.181 \pm 0.0020	0.019 \pm 0.002	1.171 \pm 0.088	0.143 \pm 0.001	0.013 \pm 0.0015	1.013 \pm 0.076
Female adult at first appearance of young (fresh specimens from fields)						
Maximum.....						
Minimum.....						
Average (50 individuals) ..	—	—	—	—	—	—
Male adult						
Maximum.....	0.194			0.177		
Minimum.....	0.121			0.126		
Average.....	0.149 \pm 0.0015	0.014 \pm 0.002	1.040 \pm 0.078	0.154 \pm 0.001	0.013 \pm 0.0014	0.935 \pm 0.071
Male pupa						
Maximum.....						
Minimum.....						
Average.....	—	—	—	—	—	—

TABLE 19—(Continued)

Measurements of body, femora, and tibiae in different stages of *Trionymus sacchari* (each item based on 40 individuals)

STAGES	HIND LEG					
	FEMUR			TIBIA		
	Length	Standard deviation	Coefficient of variation	Length	Standard deviation	Coefficient of variation
	mm.	mm.	per cent	mm.	mm.	per cent
First instar						
Maximum.....	0.097			0.076		
Minimum.....	0.063			0.051		
Average.....	0.084 \pm 0.0007	0.007 \pm 0.0007	0.869 \pm 0.066	0.063 \pm 0.0006	0.006 \pm 0.0007	1.079 \pm 0.081
Second instar						
Maximum.....	0.122			0.109		
Minimum.....	0.084			0.051		
Average.....	0.096 \pm 0.0012	0.012 \pm 0.0013	1.354 \pm 0.102	0.070 \pm 0.0011	0.011 \pm 0.0012	1.700 \pm 0.128
Third instar						
Maximum.....	0.160			0.109		
Minimum.....	0.084			0.042		
Average.....	0.104 \pm 0.0022	0.021 \pm 0.0023	2.230 \pm 0.168	0.075 \pm 0.0016	0.015 \pm 0.0016	2.160 \pm 0.163
Fourth instar						
Maximum.....	0.160			0.126		
Minimum.....	0.105			0.084		
Average.....	0.142 \pm 0.0019	0.018 \pm 0.0020	1.415 \pm 0.107	0.106 \pm 0.0041	0.041 \pm 0.0046	4.339 \pm 0.327
Fifth instar						
Maximum.....	0.211			0.169		
Minimum.....	0.101			0.076		
Average.....	0.151 \pm 0.0038	0.035 \pm 0.0044	0.292 \pm 0.220	0.117 \pm 0.0029	0.027 \pm 0.0030	2.598 \pm 0.196
Sixth instar						
Maximum.....	0.244			0.177		
Minimum.....	0.110			0.067		
Average.....	0.171 \pm 0.0035	0.033 \pm 0.0037	2.140 \pm 0.161	0.129 \pm 0.0029	0.027 \pm 0.0030	2.356 \pm 0.178
Newly emerged adult						
Maximum.....	0.228			0.177		
Minimum.....	0.126			0.092		
Average.....	0.186 \pm 0.0028	0.026 \pm 0.0029	1.543 \pm 0.116	0.152 \pm 0.0023	0.021 \pm 0.0024	1.559 \pm 0.118
Female adult at first appearance of young (balsam mount from cultures)						
Maximum.....	0.227			0.194		
Minimum.....	0.160			0.135		
Average.....	0.205 \pm 0.0017	0.016 \pm 0.0018	0.865 \pm 0.065	0.171 \pm 0.0013	0.013 \pm 0.0014	0.812 \pm 0.061
Female adult at first appearance of young (fresh specimens from fields)						
Maximum.....						
Minimum.....						
Average (50 individuals).....	—	—	—	—	—	—
Male adult						
Maximum.....	0.185			0.206		
Minimum.....	0.143			0.143		
Average.....	0.159 \pm 0.0011	0.011 \pm 0.0012	0.742 \pm 0.056	0.180 \pm 0.0016	0.015 \pm 0.0017	0.922 \pm 0.700
Male pupa						
Maximum.....						
Minimum.....						
Average.....	—	—	—	—	—	—

TABLE 19a

*Differences in body lengths and widths between successive instars.
(Computed from table 19)*

STAGES	DIFFERENCES IN AVERAGE LENGTH		DIFFERENCES IN AVERAGE WIDTH	
		mm.		mm.
Second instar - first instar...	0.73-0.54	0.19 ± 0.008	$0.33 \div 0.22$	0.11 ± 0.0069
Third instar - second instar..	0.99-0.73	0.26 ± 0.007	$0.44 - 0.33$	0.11 ± 0.0090
Fourth instar - third instar...	1.38-0.99	0.39 ± 0.027	$0.65 - 0.44$	0.21 ± 0.0207
Fifth instar - fourth instar...	1.55-1.38	0.17 ± 0.067	$0.76 - 0.65$	0.11 ± 0.0281
Sixth instar - fifth instar....	1.98-1.55	0.43 ± 0.067	$1.01 - 0.76$	0.25 ± 0.0229
Newly emerged adult - sixth instar.....	2.25-1.98	0.27 ± 0.049	$1.16 - 1.01$	0.15 ± 0.0259
Female adult at first appearance of young - newly emerged adult.....	2.90-2.25	0.65 ± 0.052	$1.75 - 1.16$	0.59 ± 0.0310
Adult from field - adult from cultures.....	3.96-2.90	1.06 ± 0.046	$2.13 - 1.75$	0.38 ± 0.0310

TABLE 20
Measurements of the right mesospiracle of Trionymus sacchari

	LENGTH OF SPIRA ULARIA	STANDARD DEVIATION	COEFFICIENT OF VARIATION	WIDTH OF PEISTREME	STANDARD DEVIATION	COEFFICIENT OF VARIATION
	mm.	mm.	per cent	mm.	mm.	per cent
First instar						
Maximum.....	.03			.010		
Minimum.....	.01			.005		
Average.....	.02 ± 0.0003	.003 ± 0.0003	15.0 ± 1.13	.007 ± 0.0001	.001 ± 0.0001	14.2 ± 1.070
Second instar						
Maximum.....	.03			.014		
Minimum.....	.02			.006		
Average.....	.02 ± 0.0001	.003 ± 0.0003	15.0 ± 1.13	.007 ± 0.0001	.001 ± 0.0001	14.2 ± 1.070
Third instar						
Maximum.....	.04			.020		
Minimum.....	.02			.010		
Average.....	.03 ± 0.0009	.026 ± 0.0029	86.6 ± 6.53	.010 ± 0.0006	.005 ± 0.0006	50.0 ± 3.770
Fourth instar						
Maximum.....	.06			.040		
Minimum.....	.03			.010		
Average.....	.05 ± 0.0007	.009 ± 0.0010	18.0 ± 1.35	.020 ± 0.0007	.011 ± 0.0012	55.0 ± 4.140
Fifth instar						
Maximum.....	.10			.060		
Minimum.....	.04			.010		
Average.....	.06 ± 0.0013	.012 ± 0.0013	20.0 ± 1.51	.030 ± 0.0007	.010 ± 0.0011	33.3 ± 2.512
Sixth instar						
Maximum.....	.10			.080		
Minimum.....	.05			.030		
Average.....	.08 ± 0.0013	.012 ± 0.0013	15.0 ± 1.13	.050 ± 0.0017	.016 ± 0.0018	32.0 ± 2.414
Newly emerged adult						
Maximum.....	.10			.080		
Minimum.....	.07			.050		
Average.....	.09 ± 0.0007	.010 ± 0.0011	11.1 ± 0.84	.070 ± 0.0007	.009 ± 0.0010	12.8 ± 0.966
Adult at first appearance of young						
Maximum.....	.11			.080		
Minimum.....	.07			.050		
Average.....	.09 ± 0.0007	.009 ± 0.0010	10.0 ± 0.75	.070 ± 0.0007	.007 ± 0.0007	10.0 ± 0.754

TABLE 21

Measurement of the right melaspiracle of Trionymus sacchari

	LENGTH OF SPIRACULARIA	STANDARD DEVIATION	COEFFICIENT OF VARIATION	WIDTH OF PERITREME	STANDARD DEVIATION	COEFFICIENT OF VARIATION
	mm.	mm.	per cent	mm.	mm.	per cent
First instar						
Maximum.....	.03			.010		
Minimum.....	.01			.006		
Average.....	.02 ± 0.0004	.003 ± 0.0003	15.00 ± 1.13	.007 ± 0.0001	.0011 ± 0.0001	15.70 ± 1.18
Second instar						
Maximum.....	.04			.014		
Minimum.....	.02			.006		
Average.....	.02 ± 0.0005	.005 ± 0.0006	25.00 ± 1.88	.007 ± 0.0001	.0010 ± 0.0001	14.20 ± 1.07
Third instar						
Maximum.....	.05			.020		
Minimum.....	.02			.010		
Average.....	.03 ± 0.0009	.009 ± 0.0010	30.00 ± 2.26	.010 ± 0.0008	.0070 ± 0.0007	70.00 ± 5.28
Fourth instar						
Maximum.....	.07			.060		
Minimum.....	.03			.010		
Average.....	.05 ± 0.0007	.009 ± 0.0010	18.00 ± 1.36	.030 ± 0.0007	.0090 ± 0.0010	33.00 ± 2.48
Fifth instar						
Maximum.....	.10			.080		
Minimum.....	.04			.020		
Average.....	.06 ± 0.0017	.014 ± 0.0015	23.30 ± 1.76	.040 ± 0.0016	.0140 ± 0.0016	35.00 ± 2.64
Sixth instar						
Maximum.....	.11			.090		
Minimum.....	.05			.030		
Average.....	.09 ± 0.0016	.015 ± 0.0017	16.66 ± 1.26	.070 ± 0.0024	.0220 ± 0.0025	31.42 ± 2.37
Newly emerged adult						
Maximum.....	.11			.090		
Minimum.....	.08			.060		
Average.....	.10 ± 0.0007	.009 ± 0.0010	9.00 ± 0.68	.080 ± 0.0007	.0080 ± 0.0009	10.00 ± 0.75
Adult at first appearance of young						
Maximum.....	.12			.110		
Minimum.....	.08			.070		
Average.....	.10 ± 0.0012	.035 ± 0.0039	3.50 ± 0.26	.090 ± 0.0007	.0020 ± 0.0002	2.20 ± 0.17

PLATES

[Magnifications indicated refer to original figures]

Plate 1

Insectary methods for Trionymus sacchari

- Fig. 1. Sugar-cane stems in battery jars.
 2. Potted sugar cane.

Plate 2

1. Work of *Trionymus sacchari* on sugar cane.
 2. Work of *Trionymus sacchari* on rice.

Plate 3

Eggs, female instars, and work on sugar cane

- Fig. 1. Sugar-cane stem with *Trionymus* colonies. $\times 1$
 2 and 3. Outlines of eggs. $\times 50$
 4. First instar, female. $\times 150$
 5. Second instar, female. $\times 150$
 6. Third instar, female. $\times 150$
 7. Fourth instar, female. $\times 150$
 8. Fifth instar, female. $\times 150$
 9. Sixth instar, female. $\times 150$
 10. Young adult, female. $\times 150$
 11. Gravid adult, female, with seven-segmented antennae. $\times 150$
 12. Gravid adult, female, with eight-segmented antennae. $\times 150$

Plate 4

Antennae, female

- Fig. 1. First instar. $\times 660$
 2. Second instar. $\times 660$.
 3. Third instar. $\times 660$.
 4. Fourth instar. $\times 660$.
 5. Fourth instar; segments 3a and 3b+c showing close association. $\times 660$
 6. Fifth instar, six-segmented. $\times 660$
 7. Fifth instar, seven-segmented. $\times 660$
 8. Sixth instar, six-segmented. $\times 660$
 9. Sixth instar, seven-segmented. $\times 660$
 10. Sixth instar, eight-segmented; segments 3b and 3c incompletely divided. $\times 660$
 11. Sixth instar, eight-segmented. $\times 660$
 12. Adult female, gravid, seven-segmented. $\times 660$
 13. Adult female, gravid, eight-segmented.
 14. Adult female, freshly emerged, eight-segmented. $\times 660$

Plate 5

Anterior portion of body and basal mouth parts, female

- Fig. 1. First instar. $\times 660$
 2. Second instar. $\times 660$
 3. Third instar. $\times 660$
 4. Fourth instar. $\times 660$
 5. Fifth instar. $\times 660$
 6. Sixth instar. $\times 660$
 7. Young adult. $\times 660$
 8. Gravid adult, anterior portion of body. $\times 150$

Plate 6

Right series of legs, female. ×660

[Roman numerals refer to instars; arabic, to legs]

Plate 7

Posterior portions of abdomen, female

- Fig. 1. First instar. ×660
2. Second instar. ×660
3. Third instar. ×660
4. Fourth instar. ×660
5. Fifth instar. ×660
6. Sixth instar. ×660
7. Adult. ×660
8. Anal ring, adult. ×660
9. Anal-lobe seta, adult. ×660
10. Seta on penultimate abdominal segment, adult. ×660
11. Anal-ring seta, adult. ×660
12. Typical abdominal pores and hairs, adult. ×660

Plate 8

Male

- Fig. 1. Adult male, dorsal view. ×90
2. Adult male, ventral view. ×90
3. Pupa. ×90
4. Pupal case. ×90
5. Right antenna. ×660
6. Left haltere. ×660
7. Right fore leg. ×660
8. Right middle leg. ×660
9. Right hind leg. ×660
10. Head, ventral view. ×660
11. Caudal end of abdomen. ×660



Fig. 1



Fig. 2

PLATE 1

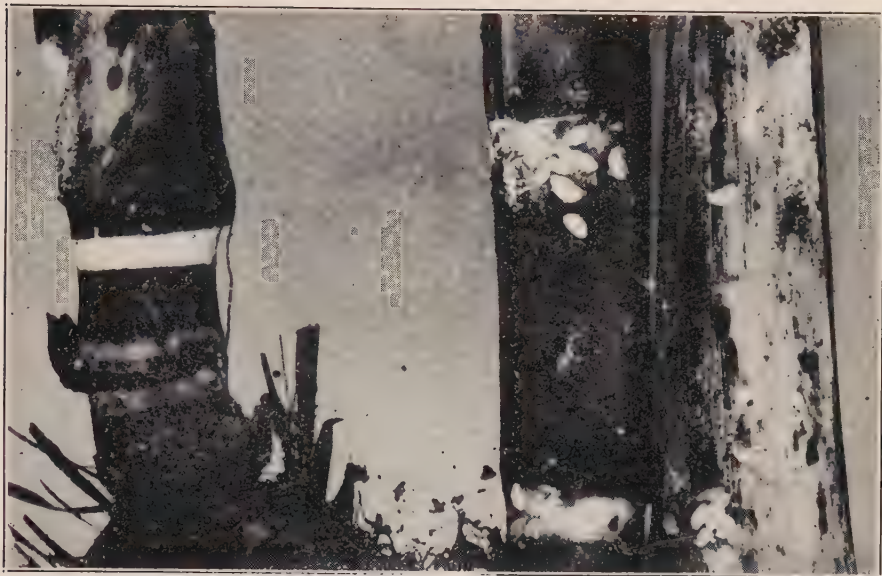


Fig. 1



Fig. 2
PLATE 2

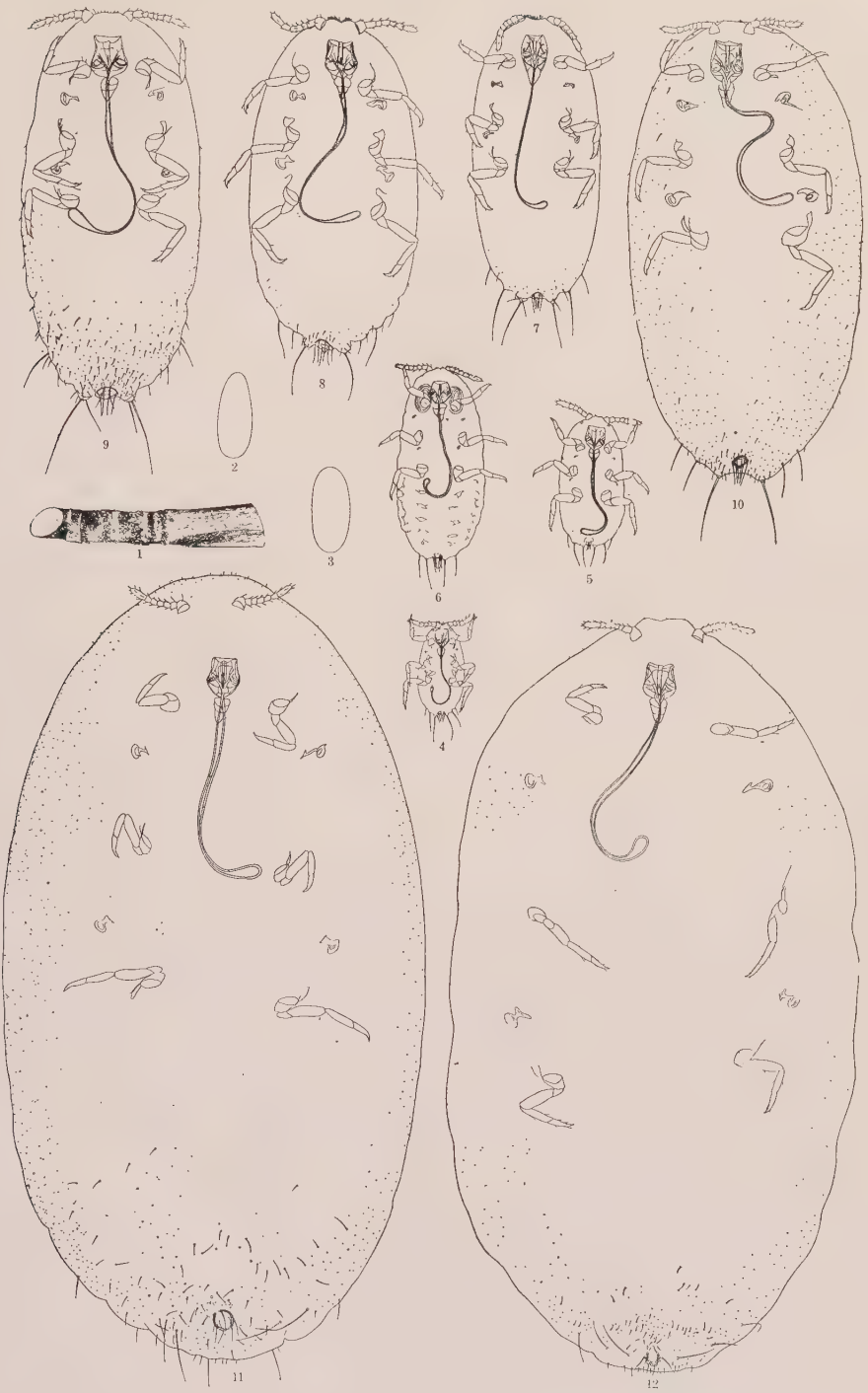


PLATE 3

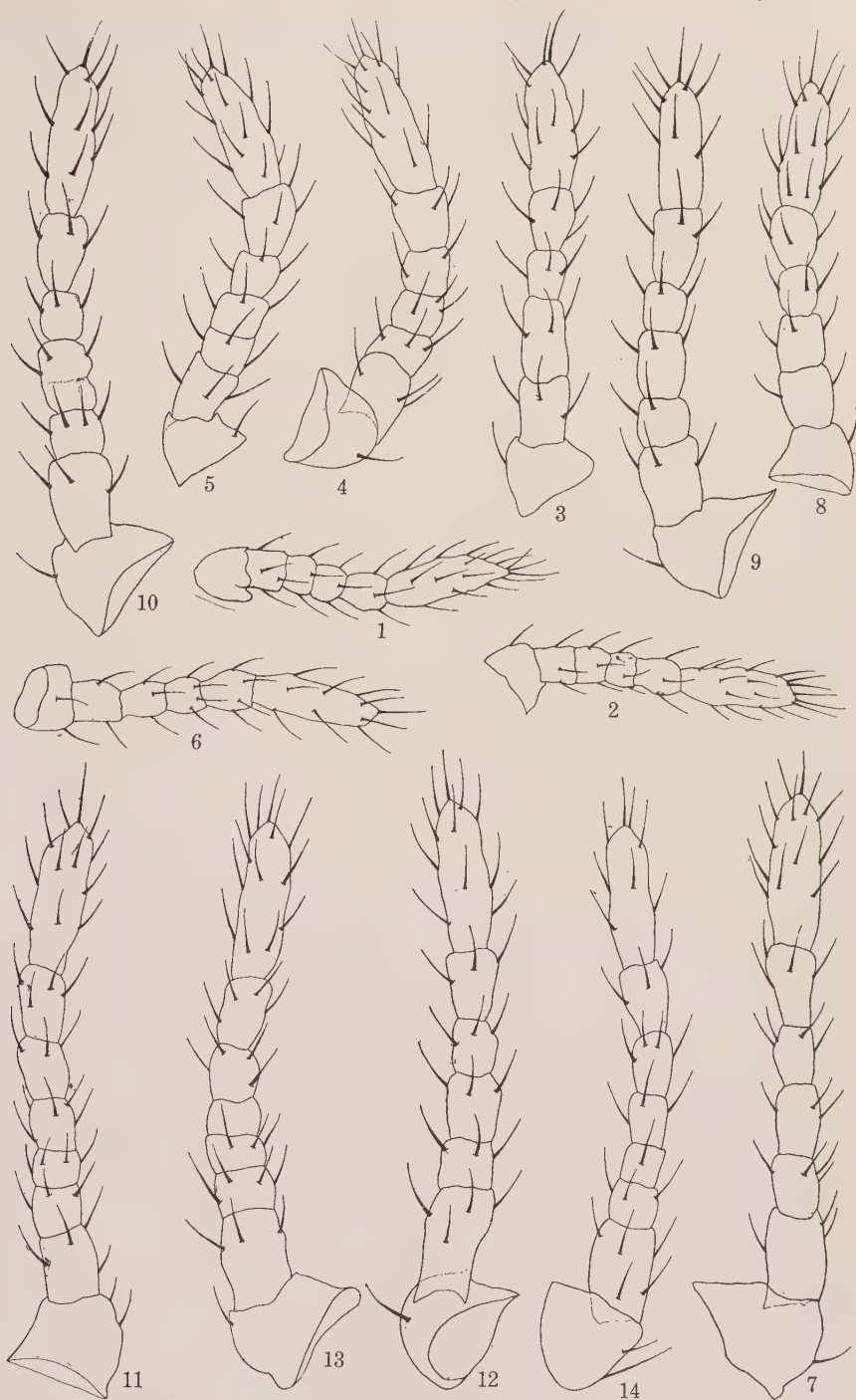


PLATE 4

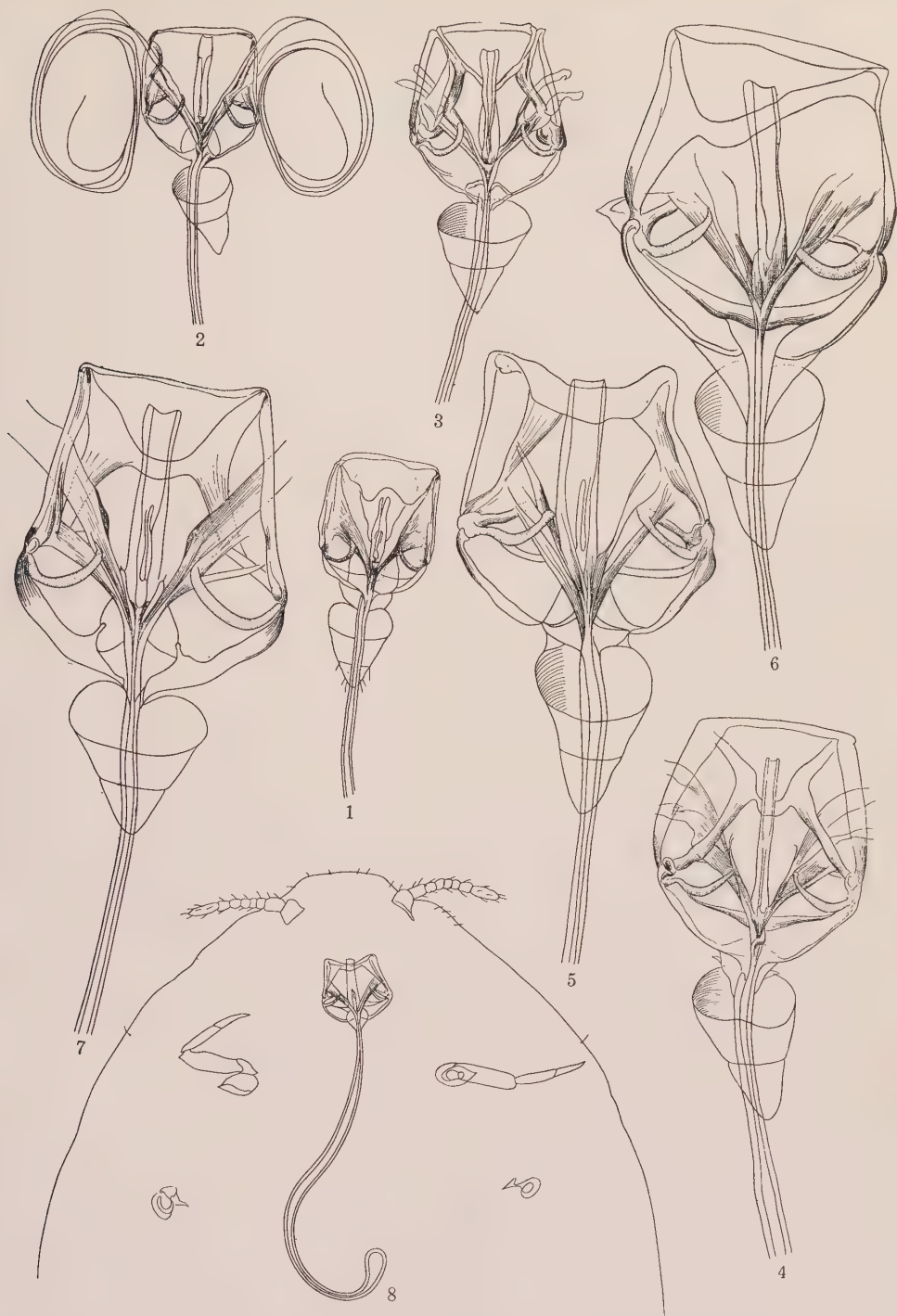


PLATE 5

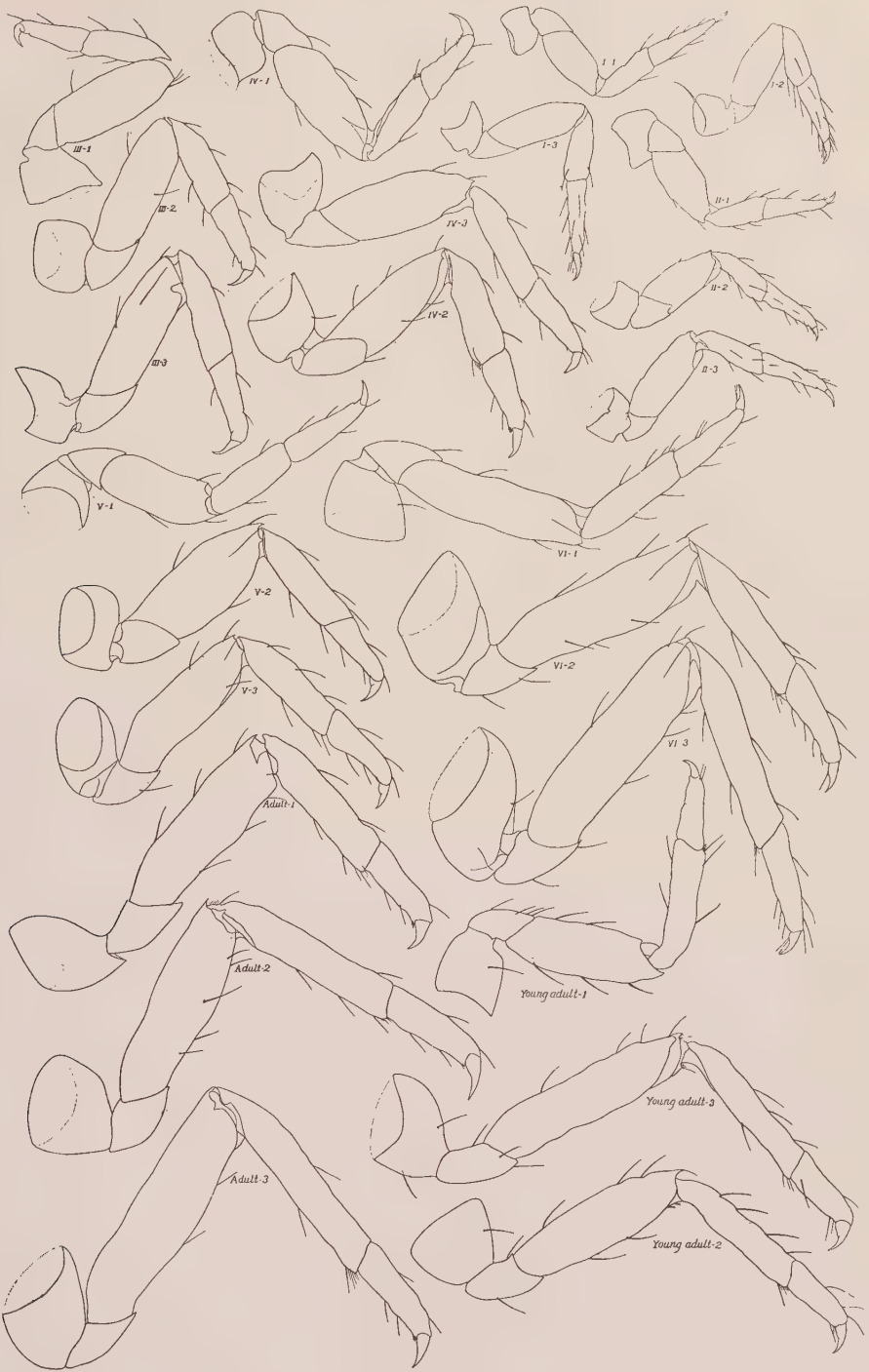


PLATE 6



PLATE 7



PLATE 8

COST OF HARVESTING CASSAVA WITH A PLOW¹

ALEJANDRO B. CATAMBAY

Of the Department of Agricultural Engineering

WITH TWO TEXT FIGURES

Cassava production and cassava starch manufacture promise to become important industries in the Philippines. Many prospective cassava planters have visited the College to secure information about the different phases of these industries. Some of these planters were especially interested in finding some way of reducing the cost of harvesting, the most important factor to be considered in the cost of production of cassava.

This study was undertaken to test a method of harvesting cassava that would involve less expense, it was thought, than the digging up of the roots by hand, which is the common practice.

The work was conducted in the College Experiment Station under the Department of Agronomy. The cassava culture used was planted in November, 1930 and harvested in January, 1932.

The field has an area of 1,912 square meters and was planted to variety Kapo White. One-half was harvested by the ordinary method of digging out the roots with a mattock and the other half was plowed up with a tractor and a suitable plow.

The tractor used in the test was the standard Fordson which developed approximately from 8 to 10 horse power at the drawbar and from 16 to 20 at the belt.

In selecting the plow to be used the different types of moldboard were considered. There are three general types of moldboard; the stubble, the sod, and the general purpose. The stubble moldboard is short and has an abrupt curvature; the sod moldboard is long with a gradual curvature; that of the general purpose is ordinarily between the two.

The sod type was selected because of the gradual curvature which slowly lifts the soil, hence would slowly lift the cassava roots, thus minimizing the breaking of the roots.

The particular plow used in this study was the "Prairie" breaker which has a long moldboard, wide throat, and big clearance. These features in the construction prevent clogging the plow with trash.

METHODS OF TESTING

Cultural methods

The land preparation involved two plowings and two harrowings before the field was finally furrowed. There were two cultivations before

¹Experiment Station contribution No. 820. Received for publication April 20, 1932.

the plants reached a height of one meter. Then hilling followed with the use of native plow. When the plants reached a height of one meter, cultivation was stopped as there would be danger of injuring the young roots which were in the process of development.

One weeding with the native hoe was given before the plants reached maturity.

Harvesting

Before the cassava was harvested, the stems were cut leaving a portion about 15 cm. long above the ground. These topped portions of the stem



Fig. 1.—Showing plowing out of cassava roots.

served as a guide to the tractor driver.

Two methods of harvesting, digging up roots by hand and plowing them out, were used. The time required by each method was recorded.

Digging up roots by hand. This operation was performed to serve as control. The men who dug the cassava used mattock axes. They dug around the stem tracing the roots and then pulled up the whole root system. The tip of the cassava roots usually broke leaving a small portion in the ground. This portion had to be sacrificed because of the labor cost if each root were traced to the tip.

Plowing up roots with tractor-drawn Prairie sod plow. With this method three men were required to do the harvesting. One drove the tractor, one managed the plow, and one followed the outfit gathering the roots and putting them aside so that they would not be run over by the tractor in the next round. Figure 1 shows the operation of plowing out the cassava roots.

TABULATED RESULTS

Hand digging

Area of lot.....	956	square meters
Labor required.....	63.75	man-hours
Cost of digging:		
Labor, at ₱0.11 per man-hour.....	₱7.01	
Implement cost (use of mattock).....	0.04	
Total.....	₱ 7.05	

Cost of harvesting per hectare.....	₱73.74
Time to harvest one hectare.....	666.84 hours

Plowing up roots

Area of lot.....	956	square meters
Time required.....	1.5	hours

Labor cost:

1.5 man-hours (tractor driver) at ₱0.17.....	₱0.26
1.5 man-hours (guiding plow) at ₱0.11.....	0.17
1.5 man-hours (gathering roots) at ₱0.11.....	0.17

Total.....	₱0.60
------------	-------

Machinery cost:

Depreciation of and interest on tractor.....	₱0.32
Supply cost of tractor.....	1.31
Depreciation of and interest on plow.....	0.06

Total.....	₱1.69
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Total cost of harvesting.....	₱2.29
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Cost of harvesting per hectare.....	23.96
-------------------------------------	-------

Time to harvest per hectare.....	15.64 hours
----------------------------------	-------------

In computing the depreciation of machinery and interest on invested capital the formulas² by Catambay (1931) were used.

DISCUSSION OF RESULTS

Cost of harvesting

It will be observed that there is a big difference in the cost of harvesting cassava by the two methods tried. With hand digging it cost ₱73.74 per hectare and only ₱23.96 when the roots were plowed up. It cost ₱49.78 more to dig up the roots by hand, the common practice, than it did to plow them out. Considering the length of time required per hectare it will be noted that it required 666.84 man-hours to harvest one hectare by digging. When the roots were plowed out it required only 15.64 hours.

Effects of the methods on the roots

When the root system was pulled up after digging around the stem, some of the roots broke and portions at the tips were left in the ground. Digging the roots from the base to the tip would require a much longer time than just pulling up the root system.

It was observed that when the roots were plowed out at a depth of 8 inches (20.16 cm.) some of them broke and portions were left in the ground. The depth was increased from 10 to 12 inches (25.4-30.48 cm.) by raising the point of hitch and the result was very satisfactory. The breaking of the roots was so little that practically none were left in the ground.

²Catambay, Alejandro B. 1931. Plows and plowing: IV Cost of plowing with different plowing outfits. *The Philippine Agriculturist* 20: 410-422.

It will be observed in figure 2 that the difference between the breaking of the roots when dug up and when plowed out is not very marked.

Effect of the methods on the field

The holes from which the roots were dug made the surface of the fields uneven. These holes greatly interfered with the next plowing. They made the field uncomfortable for the work animals to walk on.

The field from which the cassava roots were plowed up presented a practically level surface. The field being plowed up saved at least the first plowing for the next crop. Another advantage with this method was that because of the extraordinary deep plowing required the weeds and trash were plowed under. The field consequently appeared clean and level as after a regular plowing.



Fig. 2.—The pile of cassava roots at the left was dug up and that at the right was plowed out. Note that there is little difference in number of broken roots.

SUMMARY

1. The cost of harvesting cassava with hand digging was ₱73.74 per hectare.
2. Harvesting cassava by plowing the roots out with a tractor-drawn plow proved relatively cheap. It cost ₱23.96 or ₱49.78 less than by the hand method.
3. Cassava can be harvested in a much shorter time by plowing the roots out with a suitable tractor-drawn plow than by digging them up. It took 15.64 hours with the plow to harvest one hectare. Harvesting one hectare by digging required 666.84 man-hours.
4. In the loss through breaking of roots there was no marked difference in the two methods.
5. Digging cassava made the field uneven which interfered with the next plowing.
6. The field from which the roots were plowed out presented a clean and level surface because the weeds and trash were plowed under.
7. Plowing cassava roots out saved one plowing for the next crop.

ABSTRACT¹

Decomposition of certain green manures as affected by certain fertilizing materials. FELIX D. LAZO. (*Thesis presented for graduation, 1930, with the degree of Bachelor of Agriculture, from the College of Agriculture No. 422; Experiment Station contribution No. 831*)—This study was conducted to determine the influence of certain fertilizing materials; namely, lime, ammonium sulfate, ammonium phosphate, potassium sulfate and farmyard manure on the rapidity of the decomposition of certain green manures. The green manures used were New Era cowpea [*Vigna sinensis* (Linn.) Savi.], Ami soybean [*Glycine max* (Linn.) Merr.], otong-balatong (*Phaseolus calcaratus* Roxb.) and mungo (*Phaseolus mungo* Blco.). This study was carried on in the laboratory and in the field.

Mason jars of about one quart capacity were used to hold the soil. The soil used contained twenty per cent of moisture. The fertilizers and the green manures were thoroughly mixed with the soil in the mason jars. The field that was used was divided into lots. In each lot, holes of about 30 centimeters deep were dug. The green manure was put in the holes. The fertilizers and the green manure were thoroughly mixed, put in the holes, and then soil was added and thoroughly incorporated. The amount of fertilizers used was calculated on the basis of 500 kilograms each of ammonium sulfate, potassium sulfate, and ammonium phosphate; 2000 kilograms of lime and 5000 kilograms of farmyard manure per hectare. The state of decomposition was examined biweekly.

This study disclosed that: (1) Under laboratory conditions the green manure was completely decomposed within ten weeks. (2) Under field conditions the green manures were eaten by termites. (3) The green manures that were not eaten by termites were decomposed within two weeks, except the skeletons and the woody portions. (4) Fungus grew in the green manures during the decomposition, but no bad odor was given off. (5) Under both laboratory and field conditions lime and farmyard manure hastened the decomposition of the green manures; ammonium sulfate and ammonium phosphate lengthened the time of decomposition; potassium sulfate had no effect on the decomposition of green manures. (6) Of the four legumes studied, New Era cowpea gave the highest tonnage of green manure.

It is recommended that: (1) Green manuring should not be practiced in fields that are badly infected with termites. (2) Farmyard manure may be added to the soil to hasten the decomposition of green manure.

—Lauro A. Ynavez.

¹Abstract prepared as part of required work in English 3a, College of Agriculture.

COLLEGE AND ALUMNI NOTES

Dr. Saul B. Arenson of the Department of Chemical Engineering of the University of Cincinnati was a Campus visitor on June 28. Doctor Arenson was a former associate in the University of Nebraska of Dr. H. G. Deming, first head of the Department of Agricultural Chemistry of this College. Doctor Arenson brought messages of friendship to the many former pupils of Doctor Deming now on the faculty of the College.

Dr. A. Frey-Wyssling of the University of Zurich was a Campus visitor on June 28. He was engaged for four years in rubber selection in Sumatra. After climbing Mount Maquiling to the Mud Spring he was shown around the Campus by Dean Gonzalez and conferred with Doctors Mendiola, Espino, and Ocfemia.

Dr. F. W. Foxworthy, accompanied by Dr. E. B. Copeland, visited the Department of Plant Physiology July 1, 1932. Doctor Foxworthy was formerly a member of the Faculty of the College of Agriculture when the School of Forestry was a part of the College. For the past decade and a half he has been with the government of the Federated Malay States as forest botanist with headquarters at Kuala Lumpur.

Dr. E. B. Copeland is a frequent visitor of the Department of Plant Physiology. He is interested in the development of the herbarium of the department, and frequently consults it to gather materials for a book on the *Flora of Mount Makiling* which he is planning to write.

On June 28, 1932, Messrs. J. E. Kennedy and O. A. Laird of the Philippine Sugar Recoveries, Inc., in Manila came to the College of Agriculture to ask the coöperation of Dr. G. O. Ocfemia of the Department of Plant Pathology and Professor R. H. King of the Sugar Technology Division, in the cultivation of the yeast which is employed in the Olivarius process for recovering sucrose from cane molasses. The yeast cultures in ampules came from San Francisco, California, and they were brought to the Philippines personally by Mr. Laird. Some of the ampules were kept in the refrigerator throughout the trip from the United States to the College of Agriculture and others were carried by Mr. Laird in his coat pocket.

Doctor Ocfemia found that the yeast grew slowly when transferred to malt-extract solution of 12° Brix, a medium prepared as directed by Mr. Laird. However, when entire tubes of the malt-extract cultures were added

to molasses which was diluted to 21° Brix the yeast worked very fast. The yeast appears to be very similar to *Monilia vini* Osterwalder, an organism which "ferments dextrose and levulose especially, and saccharose, lactose and galactose less actively." This organism was described by A. Osterwalder in "Ein neue Gärungsmonilia, *Monilia vini*, n. sp." published in *Centralblatt für Bakteriologie*, Abteilung II, 1912.

The yeast cultures were turned over to Professor King for use experimentally in the recovery of sucrose from molasses. A stock culture of this organism is kept in the Department of Plant Pathology.

The Bureau of Prisons is greatly indebted for the keen interest taken by the College of Agriculture, University of the Philippines, the Bureau of Animal Industry, and the Bureau of Plant Industry, in the advancement of its purposes. Through their coöperation it has been possible to make important improvements in the administration of the colony [Iwahig Penal Colony] and so coördinate the work pertaining to agriculture, farm management and animal husbandry as to yield the maximum of good results.

Excerpt from the report, under date September 14, 1931, of the Director of Prisons to the Secretary of Justice.

In acknowledging receipt of a recommendation made by Dean Gonzalez of a graduate of this College, Mr. H. Atherton Lee, Director of Research in the Philippine Sugar Association, wrote the Dean as follows:

"All the men whom you have recommended to us in the past have succeeded beyond question and, therefore, we place great dependence on your recommendations."

The seventy-third scientific meeting of the Los Baños Biological Club was held on June 30, 1932, at 7:30 p. m., in the Lecture Hall of the Department of Agricultural Chemistry.

The following papers were read and discussed:

1. "The effect of cane molasses on the nitrate content of a clay loam soil kept under varying conditions of moisture." By H. E. Lumang and L. J. Villanueva. (Paper read by Mr. H. E. Lumang).
 2. "Agronomical problems of the Iwahig Penal Colony." By Dr. N. B. Mendiola
 3. "Report on a trip to the Iwahig Penal Colony." By B. M. Gonzalez.
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Among recent Campus visitors was Mr. Canuto Manuel, B. Agr. '24. Mr. Manuel received the degree of Ph. D. last February from University

of Michigan. He specialized in ornithology. Doctor Manuel is employed in the Bureau of Science.

Mr. Cornelio Crucillo, B.S. Agr. '27, was a Campus visitor in June. Mr. Crucillo is on the office staff of Dr. Manuel Roxas, Director of the Bureau of Plant Industry.

A new College enterprise is the *College of Agriculture Biweekly Bulletin*. The editor is Dean Gonzalez and the assistant editor is Dr. F. M. Sacay of the Department of Agricultural Education. The principal feature of the bulletin is a brief report on some experimental work of practical use to farmers that has been done in the College. Notes on the Alumni and items of College news form another feature. Letters from graduates expressing their welcome of the *Bulletin* have been received.

This bulletin which is mimeographed, is the successor to the former College New Service.

A letter to Dean Gonzalez from Doctor Francisco, en route as delegate to the Pacific Regional Health Conference of the World Federation of Education Association, tells of his visits to Hongkong University, the "war" ruins in Shanghai and the medical college and hospital of Osaka University.

Mr. Juan Regina, B. Agr. '28, agricultural assistant in Talisay-Silay Milling Co., Occidental Negros, writes that the following College graduates are employed by sugar planters. Juan Estanol, B. Agr. '27, is with Hacienda Socorro, Bacolod; Francisco Mendoza, B. Agr. '22, with another hacienda in Bacolod; Lorenzo Paderna, B. Agr. '28, with a hacienda in La Carlota; Irineo Malagaya, B. Agr. '25, with Hacienda Carmuno, in Escalante; Melanio Calinisan, B. Agr. '28, of Bureau of Plant Industry has been directing locust extermination on sugar plantations.

Getulio B. Viado, member of the 1933 class, accepted employment as assistant entomologist in the Philippine Sugar Association. Mr. Viado sailed on the S. S. *Venus* for Negros to help in the locust campaign in the cane fields of that island.

Mr. Agapito Buenaventura, B. Agr. '22, is principal of Banga Rural High School, Capiz. In this school are Mr. Anastasio Rowan, B.S.A. '23, Mr. Antero Inciong, B. Agr. '27, Mr. Julian A. Belo, B. Agr. '28, and Mr. Albino Vidal, B. Agr. '29.

The regular annual Intramural Athletic Meet for the academic year 1932-1933 in the U. P. Los Baños was formally opened Tuesday afternoon, June 14, 1932. Dr. R. B. Espino, President of the Los Baños Sub-Board of Athletic Management, was introduced by Physical Director, Nicolas Machan. Doctor Espino welcomed the new as well as the old athletes. He then pointed out that in addition to the usual accepted benefits derived from athletics, there is another important one, the opportunity it offers for overcoming the "inferiority complex" which hampers many students.

Doctor Espino tossed the first ball in the first encounter this College year in basket ball between the Aggie Freshmen team and the Forestry team.

AGRICULTURAL EDUCATION AMONG NEGROES IN SOUTHERN UNITED STATES: I¹

This article aims to present the result of the author's study of the system of agricultural education among the Negroes in the southern section of the United States. This study was made in the early part of 1931. The writer spent two weeks at Tuskegee Institute and in other parts of Alabama; one week in the Southern Carolina Agricultural and Mechanical College at Orangeburg, and vicinity, South Carolina; and one week in Hampton Normal and Industrial Institute and vicinity, at Hampton, Virginia.

In this article the writer discusses two phases of agricultural education; namely, (1) vocational education in agriculture in schools, and (2) agricultural extension work.

THE NEGRO IN SOUTHERN AGRICULTURE

The Negro plays a very important rôle in southern United States agriculture. According to T. J. Woofter's report in 1930 on the economic status of the Negro, 30 per cent of the farms in the South in 1920 was operated by Negro farmers as owners and tenants. And 45 per cent of Negroes gainfully employed was engaged in agricultural pursuits. The majority of the Negro farmers are tenants. In 1925 about three-fourths of the Negro farmers were tenants.

The size of the farm operated by a Negro is about 70 acres on the average, half of which is productive. In 1925 the modal-sized farm was between 20 to 49 acres. The Negro farmer has usually one mule for work animal, and he sometimes keeps a few chickens and pigs. Very often, his home has only one or two rooms, and is in a poor state of repair.

Type of farming

"The southern farmer is a one-crop man and especially is this true of the Negro farmer", writes Woofter (1930). In the Southeast, the Negro farmers derive their income largely from cotton,

¹ General contribution from the College of Agriculture No. 314.

The author wishes to acknowledge his indebtedness to Dean B. M. Gonzalez, at whose suggestion this article was written.

and those living a little farther north, largely from tobacco. Corn is also grown in the South, but only for home use. Woofter reported that in 1925, in states heavily populated by Negroes, such as Georgia, Alabama, Mississippi and South Carolina, 43 per cent of the harvested land was in cotton and tobacco, 41 per cent in corn, and only 16 per cent in other crops.

The prosperity of the Negro farmer is therefore measured by the market price of his major crop. The present low price of cotton is the cause of the present plight of the Negro farmers. Crop diversification has been offered as a remedy. It appears that, so far, no very satisfactory substitute has been found for cotton as a money crop. The introduction of other crops already produced in other sections of the country is considered not wise, for it will result in over-production of those crops.

A campaign has been launched to interest the farmer in growing on his farm as much food as his family needs—corn, potatoes, peanuts, vegetables, meat,—and to devote the rest of the farm acreage to export crops.

As a result of the decline of prices of cotton and tobacco, the important cash crops in the South, thousands of acres in farms have been abandoned. The high level of industrial wages compared with the farm wages has stimulated the migration of Negroes from rural communities to industrial centers.

Many farmers who bought land, expensive tools and equipment, and made improvements during the period of inflated prices, now find large debts to pay with low-priced products.

Farm income

Studies made by Clarence Heer of the University of North Carolina show that the per capita production of southern agricultural laborers in 1928 was \$1,038, or about 51 per cent of the per capita production in other sections of the United States. (Woofter, 1930.)

The study made in 1927 by the North Carolina State Tax Commission gave an average cash income of \$556 and average family living from farm of \$478. The median cash income was \$250. (Woofter, 1930.)

The annual income of the Negro farmer is much lower than the above figures. In a study of Negro-owned farms cited by Woofter, the average cash income plus family living amounted to \$420 in 1928. Other studies showed \$399 in one county and \$448 in another. These amounts included all incomes, including wages received for work done outside the farm. Because of this low income

the standard of living of the Negro farmer is low. The system of agricultural education in the South is accomplishing a great deal in raising this standard.

VOCATIONAL EDUCATION IN AGRICULTURE

For many years vocational education in agriculture has been offered the Negroes in several Federal and State schools, but facilities were meager and inadequate. In 1917, however, Congress passed the Smith-Hughes Act, increasing support for this type of education. It made possible the inclusion of vocational agriculture in many Negro public high schools. The Act provides appropriation of funds "to be paid to the respective States for the purpose of coöperating with the States in paying the salaries of teachers, supervisors, and directors of agricultural subjects, and teachers of trade, home economics, and industrial subjects, and in the preparation of teachers of agricultural, trade, industrial, and home economic subjects." And that "for each dollar of Federal money expended for such salaries the State or local community, or both, shall expend an equal amount for such salaries." In 1930 the United States spent a total of \$8,749,072.31 for vocational agriculture. Of this amount, \$3,173,623.52 was Federal money and \$5,575,448.79 came from State and local sources, according to the report (1930) of the Federal Board for Vocational Education.

Organization

The administration of vocational education in agriculture in each state is placed in the hands of a director of vocational education assisted by a supervisor of vocational agriculture. Immediately under the supervisor are the teachers of vocational agriculture.

In many high schools the full time of an agricultural teacher is utilized in teaching the course in agriculture, a course added to the existing program of studies. In small high schools, he also teaches academic subjects. This type of school organization in which a department of agriculture is added to the existing academic high school differs from previously established vocational schools of agriculture. The majority of Negro pupils enrolled in vocational agriculture at present are attending schools of the new type.

Before a high school is granted permission by the state to add a department of agriculture and offer courses in vocational agriculture, certain requirements must be met. A school must have a sufficient number of students, available space for classroom and laboratory, and necessary equipment. School farms are not necessary in

many states, although the law requires students to have at least six months of supervised farm practice. This work is done on the home farm or on some other farm in the community.

The teacher's program of work

As by the White teachers, four types of program are carried out by Negro teachers of vocational agriculture. These are: (1) day classes for regular pupils, (2) day-unit classes, (3) part-time classes for out-of-school boys, and (4) evening classes for adults. The Act provides that "the course be designed to meet the needs of persons over 14 years of age who have entered upon or who are preparing to enter upon the work of the farm or of the farm home." The law does not specify the grade attainment or educational qualification of the person to be taught. Nor does it specify how many years the course should extend. In the states visited by the writer, the course in vocational agriculture is first offered to pupils in the last one or two grades of the elementary school. This is followed by two or more years in the high school, depending upon the number of grades offered by the high school.

Day and day-unit classes

The day class or day school is attended by the regular students of the high school. The class meets for about 90 minutes every day. There is no definite course of study. Each teacher constructs his course after making a survey of the community to determine what should be taught to the students and what training should be given to prepare them to become successful farmers. Emphasis is placed upon the crop and animal enterprises dominant in the area in which the school is located. Since farm problems change from year to year, the teacher changes his course of study accordingly.

The instruction is closely correlated with supervised practice or project work. Units of instruction center around the problems met in their practical work. Subject-matter is not taught in a logical order but farm jobs and farm problems are usually taught according to seasonal sequence. The common methods of instruction used are discussion of problems, demonstration, laboratory work, field trips, classroom study, and talks by teachers and other individuals. The students run their home projects as regular business enterprises in which improved methods of farming are employed. Accurate records of costs, value of production, and profit are kept.

Day-unit classes are offered in some states. In high schools with a limited number of students, the teacher may devote half of the day to day-unit classes organized in other schools. The teacher meets each of such classes for usually two ninety-minute periods a week.

Part-time and evening classes

Part-time classes form the third phase of the work of the agricultural department of the high school. These classes are attended by farmers' sons who have already left school and have started to work on the farm. They are induced to return to school during certain parts of the year to study agriculture and possibly other subjects. The aim is to increase their vocational and civic efficiency.

Evening schools or classes in vocational agriculture for adult farmers are also conducted by the agricultural department of the high school. The work is usually undertaken by the teacher handling the day class. The evening class usually meets in the evening, although this is not always the case. In many states, each class is required to meet for at least ten sessions. The group meets usually once a week.

The course of instruction centers on a certain specific phase of farming. The content of the course is based on the needs of the members of the group. The work deals with the solution of actual problems of the farmers. It is very important, therefore, that the teacher should possess technical training and practical experience on the subject of the course. The teacher must also know how to teach the farmers who have low educational attainment. Highly technical lectures will not benefit this type of students. Conference and discussion methods are usually used. The more experienced farmers may furnish the answers to some of the problems brought up.

As with students enrolled in other classes, the members of the evening class are required to have at least six months of supervised farm practice. The instructor visits each farmer to find out whether he is applying to his farm the skill or technical knowledge which he has acquired. The instructor measures his success in terms of number of farmers using improved practices, number of improved practices adopted, and increased financial returns brought thereby.

At the time of the author's visit, many evening classes were taking up the problem of "safe farming program" for their farms and communities. The price of cotton had gone down and farmers did not know what to grow. Out of the discussion participated in by those attending, coupled with technical information furnished by

the teacher, a farming program was developed. They were convinced that increased cotton production would mean ruin, and that more food crops should be grown.

Community service

The teacher of vocational agriculture engages in many kinds of promotional activities in the community. He coöperates with the extension agent. He keeps in close touch with the farmers and gives them advice. He leads and participates in social and recreational activities of the community. He undertakes other forms of community service. Hence, he is a recognized leader in the community.

During the school year 1928-29, teachers of vocational agriculture reached 18,252 Negroes in the South, or 20 per cent of the total white and colored persons reached. According to H. O. Sargeant of the Federal Board for Vocational Education, the number was distributed as follows: 9,269 pupils in 410 all-day schools; 1,870 pupils in 128 day-unit schools; 1,408 pupils in 110 part-time schools; and 5,707 persons in 320 evening schools.

The average income per pupil from supervised farm practice averaged as follows: all-day, \$100.75; day-unit, \$80.60; part-time, \$106.54; evening, \$109.65; or an average of \$103.09. The average income per pupil from supervised farm practice was 4.25 times the per capita expenditure on teacher's salary.

AGRICULTURAL EXTENSION WORK AMONG NEGROES

Few educational agencies have done more in the improvement of the life of the Negro masses living in rural communities than the agricultural extension system. Through its extensive organization it reaches people in the remotest sections of the country. It has done much to promote the prosperity and happiness of the Negro farmers and their families.

For a long time the agricultural colleges and state departments of agriculture have attempted to help rural people. These institutions held farmers' institutes, sent out men to lecture to farmers, and distributed publications. But only a limited number of farmers and farm families was reached. The passage of the Agricultural Extension Act (Smith-Lever Act) in 1914, providing Federal aid for extension work, enabled a larger number of farmers to receive the benefits of extension education. Through Federal, state, and local funds, counties were provided with farm and home demonstration agents to teach farm people and demonstrate to them improved methods and practices on the farm and in the home.

Organization

Agricultural extension work in the United States is a coöperative enterprise between the Federal government and state government. The administration of the work in the state is entrusted to a director of the extension division of the state college of agriculture. Under the director are (1) state agents for each of the three phases of extension work: (a) county agent work, (b) home demonstration work, (c) boys' and girls' club work; and (2) extension specialists. Then for each county there may be one agent for each type of extension work.

In the South, counties with a high percentage of Negro farmers employ Negro extension workers who work with the colored people. Many counties employ only county agricultural extension agents, who also undertake the club work with the boys. In more progressive counties home demonstration agents are now employed.

The agricultural extension agent is assisted in the county by committees and project leaders. The people in each Negro agricultural community is organized into a club with officers elected by the members. The officers usually serve as a committee who plan with the agent the extension program to be undertaken by the county during the year. Such a program is usually approved by all the people of the community in a meeting held for this purpose. Project leaders, each to represent a crop or animal enterprise, may also be appointed by the agent. For example, a project leader may be appointed for cotton. The committee and project leaders help the agent in planning the program of work, such as determining how many demonstrations to hold on the use of fertilizer. They also help in carrying out the program, such as locating farmers to act as demonstrators, or in announcing community meetings. They also aid in checking results of extension work, such as reporting number of farmers using a new practice and increased returns resulting therefrom. As a result of active participation by the local people, not only better plants and animals are developed, but also better individuals, individuals capable of meeting their own difficulties and of leading others in the solution of common problems.

Planning and carrying out the agent's program

The Negro county extension agent serves as a center from which valuable information is disseminated to the Negroes in the county. He resides in the county and is familiar with its problems which he discovers through observation, surveys, and conferences with farmers and other persons in the county. He learns of the successful practices of the more successful farmers in order that he may

teach these practices to the less progressive ones. He teaches the farmers of the county new practices discovered by research. He advises them as to the best way of solving their numerous problems. With his office in the county seat, usually at the center of the county, he is accessible to farmers who desire information or advice.

The first step in county extension work is the preparation of a program of activities for the county. Because the leaders and people of the county participate in its making, a program based on farm, home, and community needs is insured. The program is not limited in its aims to increasing income by better farming practices, or building a nice looking home. The program includes educational, social, and recreational aspects of the life of the farmer and his family.

During the author's visit to the South, extension programs centered on the "live at home" policy. There was an over-production of cotton; hence, farmers were being encouraged to grow their own food and the feed for their animals, to raise hogs and chickens for home consumption, and to plant gardens. The remaining acres should then be planted to cotton. In one of the community meetings of Negro farmers attended by the writer, a group of Negro farmers, in their working clothes, actually planned their farm business for the year.

The next phase of extension work is the carrying out of the program. In this the agent utilizes the more progressive farmers and the extension specialists. Various extension methods are employed by the extension agent. These are farm visits, office calls, telephone calls, correspondence, demonstrations, tours, exhibits, bulletins, circulars, letters, and meetings. The agent has an automobile and travels from farm to farm and community to community. Farm visits are very effective in teaching the Negro farmers and his family. Demonstrations also prove effective. Progressive farmers try new practices on their farms which become a demonstration for others to imitate. Through tours, farmers see improved practices used by the more progressive farmers in the community. Exhibits also bring results. Bulletins and other publications have not been very effective, probably due to the low educational preparation of the people.

Because of the variety of problems on which the farmers seek help, the agent must be a well-trained individual, with practical experience and broad technical preparation. He cannot be a specialist in all lines, so he usually makes use of extension specialists who have better training in their respective lines than the county agent.

A school on wheels

One interesting feature of the extension work among Negroes is the "auto-truck movable school". This is sent out by Tuskegee Institute and travels all over Alabama. Three or more extension agents form the teaching staff, one to deal with farm problems, another with home problems, and a nurse to deal with health problems. The truck carries necessary teaching equipment. The movable school stops for two to five days at some Negro farmer's home which is designated as a demonstration home. A large number of farmers and farm women attends and takes part in the activities. The men are taught different farm turns and practices. The women are taught improved home practices, such as making window curtains, repairing furniture, making mattresses, dresses, and other garments. The home may actually be improved, repaired, remodelled, or painted. The yard may be actually improved by planting ornamental and flowering plants. A sanitary toilet may be constructed. Knowing the poor economic condition of the Negro family, the extension agents see to it that recommended improvements are within the means of the Negro family. For example, a sanitary salt shaker is made from an empty pomade bottle, or a curtain from flour sacks.

Results of extension work

As a result of agricultural extension work, and partly owing to the work of the teacher of agriculture, many Negro farmers are now using improved methods of producing and marketing their products. They select seed, use fertilizer, and balance their farming program in order to increase their income. A larger income results in a better standard of living and greater contentment in rural life. Farm women know better methods of preparing food, selecting and remodelling clothes, improving the home environment, and taking care of the family. Farm boys and girls through club projects receive a variety of educational experiences, and get a broader view of rural life and its opportunities. The farm people are better organized. There is more frequent contact among them, and a coöperative spirit exists. Wholesome social and recreational activities among farm people have increased. Rural leaders among them have been developed. The standard of efficiency and satisfaction of colored people in agricultural communities has been raised.

FRANCISCO M. SACAY
Of the Department of Agricultural Education

THE FUSARIUM ASSOCIATED WITH SOME FIELD CASES OF HEART ROT OF ABACÁ¹

G. O. OCFEMIA AND VICTORIA B. MENDIOLA
Of the Department of Plant Pathology

WITH THREE TEXT FIGURES

THE ABACÁ HEART ROT DISEASE

Heart rot is still regarded as an important disease of abacá (*Musa textilis* Née) perhaps because the trouble is usually associated with large and nearly mature plants. Although the rotting of the heart of abacá seems to be the physiological effect of bunchy-top, fungi and bacteria have been reported to be associated with the disease. Lee and Serrano (1923) reported that they isolated from heart rot of abacá a *Fusarium* which closely resembles *Fusarium oxysporum* Schl. f. 3 Wr. n. c. (*Fusarium cubense* EFS). Teodoro (1925) states that abacá heart rot is caused by a fungus similar to, if not identical with, *Fusarium oxysporum* (*F. cubense*), the fungus which causes the banana wilt disease. Leoncio (1930) working in the Department of Plant Pathology of the College of Agriculture at Los Baños arrived at the conclusion that *Fusarium oxysporum* Schl. f. 3 Wr. may cause wilt on young abacá seedlings but the disease is usually outgrown by the fast growing plants.

Reinking in 1918 found that bacteria are present in the rotting abacá heart. Isolations made by Reinking from diseased stems yielded pure cultures of bacteria, which were capable of producing typical heart rot in artificial inoculation.

The writers believe that it may be possible for a parasitic organism to infect the youngest furled leaf of abacá and cause rotting of the tender central cylinder.

¹ Experiment Station contribution No. 833.

A portion of the data included in this paper was used by the junior author in Plant Pathology 99, Special Problem, submitted March, 1930.

Read by the senior author before the Los Baños Biological Club, March 19, 1931.

Received for publication June 3, 1932.

Ocfemia (1927, 1930, 1931) reports that of the abacá heart-rot cases in bunchy-top districts 11 to 17 per cent are secondary symptoms. In field observations at Los Baños it was also noted that the combined effects of the infestation of abacá corms with weevils, *Cosmopolites sordidus* Germar (fig. 1) and infection with bunchy-top produced more than 80 per cent of heart rot of abacá. Furthermore, the destruction of the feeding roots by various causes sometimes results in the production of heart rot.

The production of heart rot in abacá infected with bunchy-top

In describing the symptoms of abacá bunchy-top Ocfemia (1930) states that, "In some cases of bunchy-top infection of abacá, the thin chlorotic areas along the margin (of the leaves) turn brown and die starting from the edge of the leaf or from any of the thin and transparent membrane-like patches. These changes sometimes continue until the midrib is reached. Often the dead thin chlorotic portions involve the entire length of the youngest furled leaf. During the wet season the dead tissues rot and sometimes this rotting continues downwards, producing heart-rot (1927). Under favorable conditions the rotting of the central cylinder may extend as far as the corm." In the same paper this author adds that "In heart



Fig. 1.—A young abacá plant growing in the Plant Pathology Experimental Plot in 1930 photographed to show rotting of the central cylinder caused by heavy infestation of the corm by *Cosmopolites sordidus* Germar. (Photograph by the Photographic Division, Department of Soils, College of Agriculture.)

rot cases following bunchy-top, bacteria and various saprophytic fungi are present in abundance and these seem to hasten the rapid decay of the tender tissues of the heart."

THE FUSARIUM ASSOCIATED WITH SOME FIELD CASES OF HEART ROT OF ABACÁ

In 1928, 1929 and the early part of 1930 advanced cases of bunchy-top collected by plant pathology students from Laguna and Cavite provinces had various stages of heart rot (fig. 2). Some of the



Fig. 2.—Portions of the inner cylinder of two young abacá plants showing early stages of rotting of the youngest leaf resulting from field cases of bunchy-top infection collected from Paete, Laguna, March, 1929. (Photograph by the Photographic Division, Department of Soils, College of Agriculture.)

collections in December, 1929 and January, 1930 are summarized in table 1. Platings on steamed corn meal were made from the tissues of the rotting heart and in many cases these yielded a *Fusarium*. Seven typical specimens from Paete, Laguna and Mendez Nuñez, Cavite, were examined on February 9, 1929 and a total of 24 sections were made from the browning heart. Some of the sections were plated out on steamed corn meal and the others on potato-dextrose agar. The sections prepared from each stalk were as follows:

Stalk 1	.....	8 sections
Stalk 2	.....	4 sections
Stalk 3	.....	4 sections
Stalk 4	.....	2 sections
Stalk 5	.....	1 section
Stalk 6	.....	2 sections
Stalk 7	.....	3 sections

On February 12, 1929 it was found that the growth from each section was a *Fusarium* producing growth of a deep vinaceous to dark vinaceous color. On account of the occurrence of a *Fusarium* in some of the specimens studied and because heart rot of abacá has been attributed to a species similar to, if not identical with, the banana wilt fungus the present study was undertaken. In this work the morphological and cultural characters of the fungus as well as its relation to the heart rot of abacá were studied.

Morphology

The fungus was studied morphologically to determine the color, septation, branching, and contents of the mycelium; types, size, shape, color and contents of the spores; and the type, color and amount of growth on different media and substrata.

Mycelium. The mycelium in young cultures appears as fine, hyaline threads. It is granular and the cells of the hyphae are short. The hyphae of an old culture are less granular and are vacuolate. They are straight, nearly uniform in diameter, and seldom constricted at the septa.

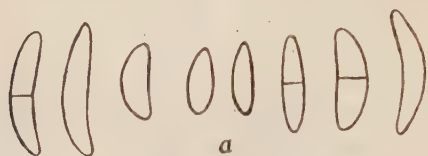
TABLE 1

The organisms associated with the rotting heart of bunchy-topped abacá collected from Paete, Laguna and Indang, Cavite

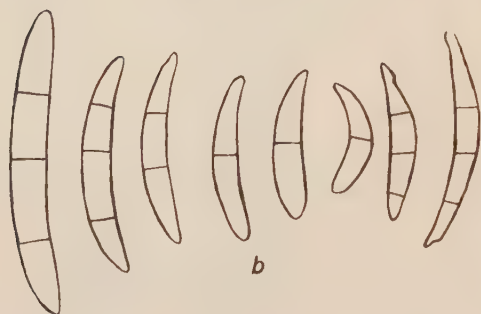
DATE OF EXAMINATION	NUMBER OF BUNCHY-TOPPED ABACÁ EXAMINED	NUMBER OF PLANTS WITH HEART ROT	ORGANISMS ASSOCIATED WITH THE ROTTING YOUNGEST LEAF		SOURCE OF SPECIMEN
			Fusarium	Bacteria	
1929					
December 28	100	18	0	18	Paete
December 28	20	7	0	7	Indang
1930					
January 9	20	7	0	7	Paete
January 14	30	9	2	7	Paete
January 23	4	4	0	4	Indang
January 23	6	6	1	5	Paete
January 24	10	10	1	9	Paete

Conidiophores. The conidiophores are produced by the aërial hyphae or in the pionnotes. The conidiophores are short lateral branches of the mycelium. They are constricted at the points of origin. On potato cylinder, they are much branched, constricted at the points of origin and at the septa and bulging in the middle. Conidia were found even in a 24-hour-old culture. They were numerous in older cultures. They vary in shape, size and septation. The septa vary from zero to five.

Microconidia. The microconidia are hyaline, oval or elongate, either 0- or 1-septate, and not in chains. Some curved 0- or 1-septate microconidia were also produced (fig. 3a). The 0-septate microconidia were from $10.1\text{--}31.5 \times 2.7\text{--}4.2\mu$; average $15.5 \times 3.5\mu$. The



1-septate microconidia were from $16.0\text{--}33.4 \times 3.1\text{--}4.5\mu$; average $23.2 \times 3.9\mu$.



Macroconidia. The macroconidia are hyaline, sickle-shaped and range from 1- to 5-septate (fig. 3b). The 2-septate macroconidia were from $20.7\text{--}34.3 \times 3.2\text{--}5.6\mu$; average $26.2 \times 4.2\mu$. The 3-septate macroconidia measured from $28.6\text{--}38.5 \times 3.4\text{--}4.3\mu$; average $31.2 \times 4.1\mu$. The 4- and 5-septate macroconidia were rare. They were found only in cultures on oatmeal agar and steamed rice. The 4-septate conidia measured from $30.2\text{--}49.8 \times 3.6\text{--}3.7\mu$;

Fig. 3.—Camera lucida drawings of (a) microconidia and (b) macroconidia. About 1050. Outline drawings by Victoria B. Mendiola.

average $40.0 \times 3.6\mu$. The 5-septate conidia were found only on oatmeal agar culture and they measured from $51.7\text{--}69.0 \times 3.6\text{--}4.2\mu$; average $60.3 \times 3.9\mu$.

The measurements of spores on different media are as follows:

Nine-day old culture on potato agar:

0-septate, $6.9\text{--}13.8 \times 3.1\text{--}5.8\mu$;
average $10.1 \times 4.2\mu$.

1-septate, $13.8\text{--}27.6 \times 2.4\text{--}6.5\mu$;
average $18.7 \times 3.9\mu$.

2-septate, $16.2\text{--}27.6 \times 3.8\text{--}6.2\mu$;
average $22.6 \times 5.0\mu$.

3-septate, $20.7\text{--}34.5 \times 3.1\text{--}6.2\mu$;
average $28.8 \times 4.3\mu$.

Eight-day old culture on potato agar plus ten per cent dextrose:

- 0-septate, $6.5-20.7 \times 2.2-5.8 \mu$;
 average $11.6 \times 3.7 \mu$.
 1-septate, $18.2-24.1 \times 3.7-6.0 \mu$;
 average $21.5 \times 4.5 \mu$.
 2-septate, $22.7-35.8 \times 5.1-6.2 \mu$;
 average $27.6 \times 5.6 \mu$.

Eight-day old culture on potato dextrose agar:

- 0-septate, $6.9-27.6 \times 2.5-6.2 \mu$;
 average $15.7 \times 3.8 \mu$.
 1-septate, $17.9-23.1 \times 3.6-5.7 \mu$;
 average $20.3 \times 4.4 \mu$.
 2-septate, $13.8-24.1 \times 2.7-4.4 \mu$;
 average $20.7 \times 3.5 \mu$.
 3-septate, $27.6-32.9 \times 3.9-4.8 \mu$;
 average $30.2 \times 4.3 \mu$.

Thirty-five-day old culture on corn meal:

- 0-septate, $6.9-22.7 \times 2.0-4.0 \mu$;
 average $13.5 \times 2.7 \mu$.
 1-septate, $13.8-20.7 \times 2.6-3.4 \mu$;
 average $16.0 \times 3.1 \mu$.
 2-septate, $24.6-27.6 \times 2.9-3.5 \mu$;
 average $26.6 \times 3.2 \mu$.
 3-septate, $24.4-34.5 \times 2.2-4.6 \mu$;
 average $29.8 \times 3.4 \mu$.

Twelve-day old culture on steamed rice:

- 0-septate, $6.9-18.4 \times 1.9-5.7 \mu$;
 average $10.9 \times 3.3 \mu$.
 1-septate, $15.8-26.5 \times 2.5-5.1 \mu$;
 average $19.3 \times 3.9 \mu$.
 2-septate, $20.7-32.4 \times 3.7-5.8 \mu$;
 average $25.7 \times 4.4 \mu$.
 3-septate, $20.7-34.5 \times 3.1-5.9 \mu$;
 average $28.6 \times 4.3 \mu$.
 4-septate, $29.8-30.6 \times 3.4-3.7 \mu$;
 average $30.2 \times 3.6 \mu$.

Nine-day old culture on oatmeal agar:

- 0-septate, $6.9-57.6 \times 1.7-5.8 \mu$;
 average $31.5 \times 3.7 \mu$.
 1-septate, $25.1-40.0 \times 3.4-4.8 \mu$;
 average $33.4 \times 4.1 \mu$.
 2-septate, $26.5-43.4 \times 3.7-4.3 \mu$;
 average $34.3 \times 4.0 \mu$.
 3-septate, $34.5-48.3 \times 3.1-5.2 \mu$;
 average $38.5 \times 4.1 \mu$.

4-septate, $48.3-51.3 \times 3.6-3.7 \mu$;
 average $49.8 \times 3.7 \mu$.
 5-septate, $51.7-69.0 \times 3.6-4.2 \mu$;
 average $60.3 \times 3.9 \mu$.

Average measurement of spores:

0-septate, $10.1-31.5 \times 2.7-4.2 \mu$;
 average $15.5 \times 3.5 \mu$.
 1-septate, $16.0-33.4 \times 3.1-4.5 \mu$;
 average $23.2 \times 3.9 \mu$.
 2-septate, $20.7-34.3 \times 3.2-5.6 \mu$;
 average $26.2 \times 4.2 \mu$.
 3-septate, $28.6-38.5 \times 3.4-4.3 \mu$;
 average $31.2 \times 4.1 \mu$.
 4-septate, $30.2-49.8 \times 3.6-3.7 \mu$;
 average $40.0 \times 3.6 \mu$.
 5-septate, $51.7-69.0 \times 3.6-4.2 \mu$;
 average $60.3 \times 3.9 \mu$.

The differences between the averages presented above and those of Wollenweber (1931) for *Fusarium moniliforme* Sheldon var. *subglutinans* Wollenweber and Reinking (p. 397) are not sufficiently great to justify its segregation from this variety.

On oatmeal agar, anastomosis of conidia was observed. From two to as many as twelve conidia anastomosed. Very often the conidia were connected by hyaline tubes between end segments. The connection occurred also between an end segment of a conidium and a middle segment of another conidium.

A conidium germinates by the production of a germ tube or two germ tubes, one at each segment. In its first stage of germination, the cells of the conidium swell a little and become constricted at the septa. After the bulging of the cells, the conidium sends out its germ tube. The conidia do not produce chlamydospores.

Forms of fructifications. Conidia were produced by the hyphae on the surface of the agar or by the aërial mycelium. They were also produced in slimy masses of spores, or pionnotes. In older cultures on potato-dextrose agar and oatmeal agar, wart-like, orange pink structures, or sporodochia were formed. The sporodochia when crushed in water were found to contain numerous conidia.

Cultural characters

The growth of the fungus was profuse on oatmeal agar, corn meal, steamed rice, and potato-dextrose agar. It was thin on corn meal agar and potato cylinders. The aërial mycelium was typically scarce and varied in color on different media.

On agar media containing dextrose, pionnotes, the color of which ranged from blackish violet² to blackish red-purple, were produced. The pionnotes are slimy masses of spores which have coalesced to form larger ones and in some cases form a solid mass.

On agar media containing dextrose the growth was faster and the color was a little deeper than that on media without dextrose. The presence of dextrose also affected the substratum of the medium. The color of the media was more intense when they contained more dextrose.

1. Cultures seven days old on potato agar plus two per cent dextrose were characterized by the presence of slimy, light buff and light ochraceous-buff stromata. The aërial mycelium was scarce, short, twisted, woolly and of pale lavender-violet color. The substratum was changed to Matthews' purple and light lavender-violet. When twenty-two days old, the color of the aërial mycelium was changed to pale flesh and a few blackish violet pionnotes were formed. The substratum became flourite violet. When thirty-seven days old, the growth became medium dense with lavender aërial mycelium and very small round slimy dusky dull violet pionnotes. At the center of the colony there was a dense mass of dirty pinkish white aërial mycelium. The substratum became dusky dull violet 2 and dusky dull violet 1.

2. Cultures seven days old on potato agar plus four per cent dextrose were characterized by an aërial mycelium that was scanty, twisted, and mauvette. The substratum was Matthews' purple.

When twelve days old, the aërial mycelium was medium dense, short, woolly, and deep vinaceous lilac. The whole growth appeared deep purplish vinaceous. The stroma was Rood's violet and slightly slimy. When twenty-two days old the aërial mycelium became scarce and pansy purple. Many large blackish red-purple pionnotes which had coalesced in most cases were produced on the stroma. The substratum became violet carmine and blackish purple. When thirty-seven days old, the growth became thick with large slimy dark livid purple masses of spores and perilla purple aërial mycelium. The substratum was perilla purple to dark naphthalene violet.

3. Cultures seven days old on oatmeal agar, were characterized by submerged, slimy, white and pale pinkish buff growth with scanty, short, woolly and dirty white aërial mycelium. The substratum was changed to light mauve and pale hortense violet. When

² Ridgway, R. 1912. Color standards and color nomenclature, 43 p., 53 col. pl. Washington, D. C.

twenty-two days old, the growth became thin, and light Amparo purple, the stroma shiny in some parts with light phlox purple pionnotes. The substratum was changed to Matthews' purple and Bradley's violet. When thirty-seven days old, the stroma possessed deep hyssop violet pionnotes and the substratum became deep hyssop violet and deep dull bluish violet 3. A three months old culture was examined microscopically and hyphal chlamydospore-like structures were found either singly, in pairs, or in chains. They were globose, thin walled and granular. The writers believe that they are not chlamydospores but mere swellings of the hyphae.

4. Cultures seven days old on corn meal were characterized with submerged, slimy and thin colorless growth. The substratum was not changed and the whole colony appeared transparent. When twenty-two days old, scanty, short, white aërial mycelium was produced, but the color of the substratum remained the same. The same characteristics were observed even when the fungous growth became old.

5. Cultures seven days old on potato cylinders were characterized by an aërial mycelium that was scanty, short, twisted, cottony and of pale flesh color. When twenty-two days old, the substratum became pale ochraceous buff. When thirty-seven days old, the stroma had bluish green tints.

Tests of the pathogenicity of the fungus

Preliminary experiments were conducted by the junior author in 1929-1930³ using twenty-four seedlings each of Bagacayon, Buñgulanon, Binoñgran, and Puti-tomatagacan varieties of abacá obtained from Mr. Domingo Baybay of the Guinobatan Abacá Experiment Station of the Bureau of Plant Industry situated at Binogsacan, Guinobatan, Albay. The seeds of these abaca varieties were germinated according to the method described by the senior author in an earlier paper (Ocfemia, 1930). Two seedlings were planted in each 24-centimeter pot of sterilized soil. The age of the seedlings when inoculated varied from 19 to 93 days. Pure cultures of the fungus isolated from heart rot of abacá and grown on slants of potato agar plus four per cent dextrose were used. The age of the cultures when used varied from 18 to 38 days.

The potted seedlings of each variety of abacá were divided into three lots of eight seedlings each. In each of the three meth-

³ Plant Pathology 99, Special Problem presented March, 1930.

ods of inoculation, four of the seedlings of each lot were inoculated and four were used as checks. The three methods of inoculation followed were:

1. A heavy suspension of spores was prepared in a small amount of sterile water in a test tube. By means of a sterilized one cc. pipette, one cc. of the spore-suspension was introduced between the youngest furled leaf and the leaf sheath that enclosed it. The furled youngest leaf and the leaf sheath were pulled slightly apart to allow the suspension of spores to get into the heart. The checks were treated in the same manner except that sterile water was used in place of the spore suspension.

2. The base of the youngest furled leaf was pricked with a sterile needle before the spore suspension was introduced. The spore suspension was applied in the same manner as in method 1. Checks were treated in the same manner except that sterile water was used instead of the spore suspension.

3. Part of the corms of the abacá seedlings was shaved off and the wounded surface was smeared with the slimy masses of spores from pionnotes produced on potato agar plus four per cent dextrose. For checks, part of the corm was shaved off and smeared with sterile agar.

In these experiments, the inoculated and check abacá seedlings were placed in the moist chamber and left there for eight to ten days. Under moist chamber conditions, the different varieties of abacá used invariably exhibited infection by the fungus, when inoculated, following methods 1 and 2. Four or five days after inoculation, water-soaked, light to dark brown areas were noted on the seedlings. The browning was produced on the furled leaf and leaf sheaths between which the suspension of the spores of the organism was introduced. The infected brown areas were more readily produced and the lesions were larger when the base of the youngest leaves of the seedlings were first pricked with the point of a sterile needle before the spore suspension was applied.

As the disease advanced, the infected areas were converted into dark brown tissues which later on caused the yellowing, wilting, bending over, and finally the dying of the upper portions of the leaves.

As in field cases, the rotting of the youngest leaf and leaf sheaths began from the upper portion of the seedlings and advanced toward the basal regions. On the tenth day after inoculation, the seedlings were removed from the damp chamber. They were placed in the experimental plot outside of the laboratory where

further rotting, yellowing and drying of the inoculated leaves were observed. Different from field cases of heart rot, however, it was noted that as soon as the infected leaves dried up, normal leaves appeared. Thirty days after inoculation the infected seedlings had nearly recovered from infection. It was noted that rotting of the heart would take place under damp chamber conditions only. When some of the infected and check seedlings were pulled up for photographic purposes the roots of the inoculated seedlings were as healthy as those of the checks. In heart rot which follows bunchy-top the growing point of the abacá is not immediately rotted although the sheath of the youngest visible leaf and the youngest furled leaf may be dead and brown. It seems that if the roots and corms are healthy the growing point may be able to send out a new healthy leaf. This was noted in the artificial inoculations to induce heart rot under damp chamber conditions described above. In advanced stages of bunchy-top of abacá the roots are dead and rotted (Ocfemia, 1930). As a result of the rotting of the roots there is no chance for new and healthy leaves to be produced by the plant and rotting of the growing point follows. However, experiments to determine the effects of removing, either partly or entirely, the roots of abacá seedlings grown in pots did not consistently produce heart rot.

The seedlings in the control pots did not show any symptom of infection by the *Fusarium* while they were in the moist chamber. Some of the leaves, however, were attacked by anthracnose caused by *Gloeosporium musarum* Mass. from which they recovered after growing in the experimental plot for some time.

In an effort to produce typical heart-rot symptoms these three methods of inoculation were repeated several times. The same results, however, were obtained each time. In the inoculation experiments it was noted that by introducing the spores through needle pricks infection was produced more readily than when the fungus was placed on the uninjured youngest leaf. No infection similar to that caused by *Fusarium oxysporum* Schl. f. 3 Wr. n. c. (*F. cubense* EFS.) (Leoncio, 1930) on the abacá seedlings was produced when the slimy spore masses of the organism were smeared on the shaved-off portion of the corms. From the results of the inoculation experiments it seems that the fungus is weakly parasitic and it is capable of infecting the tender tissues of abacá under very moist situations, such as under damp chamber conditions. When the inoculated plants are taken out of doors invasion by the fungus stops. The fungus associated with field cases of heart rot seems

to gain access into the heart of abacá only after the plant has been weakened by various causes such as bunchy-top infection, weevil infestation of the corms and perhaps other agencies. On account of the recovery of plants inoculated with the *Fusarium* associated with heart rot it seems that the disease begins as a result of some serious affection such as that by bunchy-top (Ocfemia, 1927) and other causes. The *Fusarium*, when present, hastens the disorganization of the tissues of the central cylinder.

Taxonomy of the fungus

Morphological and cultural studies show that the heart-rot *Fusarium* belongs to the section *Liseola* (Wollenweber, Sherbakoff, Reinking, Johann, and Bailey, 1925a and Wollenweber and Reinking, 1925b). The fungus is characterized by: microconidia on aërial mycelium, 0-2 or more septate, thin-walled; chlamydospores absent; macroconidia subpedicellate to pedicellate, sickle-shaped, and 2-5-septate. The 2-septate spores measure 26.2 by 4.2 μ ; 3-septate 31.2 by 4.1 μ ; 4-septate 40.0 by 3.6 μ ; and the 5-septate 60.3 by 3.9 μ . The writers refer the *Fusarium* associated with some field cases of abacá heart rot to *Fusarium moniliforme* Sheldon var. *subglutinans* Wollenweber and Reinking. This determination was confirmed by Dr. H. W. Wollenweber of the Biologische Reichsanstalt für Land-und Forstwirtschaft, Berlin-Dahlem, Germany from measurements and descriptions prepared by the writers. Reinking and Wollenweber (1927) and Wollenweber (1930) report that *F. moniliforme* Sheldon var. *subglutinans* Wollenweber and Reinking occurs on decaying leaves and pseudostem, in the vascular bundles and exterior of living pseudostem of banana (*Musa sapientum* L.) and in the air in Tela and Trujillo, Honduras, Central America. According to Wollenweber (1931) the fungus is known in Mexico, on *Zea mays* in Germany, and on rotting fruits of *Ananas comosus* (*A. sativus*) in Honduras and Panama. *F. moniliforme* Sheldon var. *subglutinans* Wollenweber and Reinking seems to be widespread in the abacá regions of the Philippines from which the specimens used in this study were collected.

SUMMARY

1. The *Fusarium* isolated from some field cases of heart rot of abacá collected from Cavite and Laguna provinces causes rotting of the youngest furled leaf under very moist situations or damp-chamber conditions. As soon as the abacá seedlings are taken out of doors, infected plants outgrow infection and recover from the disease.

2. By introducing the spores through needle pricks infection is produced more readily than by introducing them to the uninjured youngest leaves. No infection similar to that caused by *Fusarium oxysporum* (*F. cubense*) on abacá was produced by smearing the slimy spore masses on the shaved-off portion of the corms.

3. In the field, the fungus perhaps gains access into the heart of abacá only after the youngest leaf has been weakened, as when the plant is attacked by bunchy-top, when the youngest leaf is killed by various causes, or when the corms are infested with *Cosmopolites sordidus* Germar.

4. The fungus isolated from some heart-rot cases of abacá is considered identical with *Fusarium moniliforme* Sheldon var. *subglutinans* Wollenweber and Reinking.

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NITRIFICATION STUDIES OF CERTAIN PHILIPPINE SOILS ¹

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INTRODUCTION

Nitrification studies as related to crop producing power of soils

The crop producing power of the soil may vary depending upon several environmental conditions. An attempt was made in the work reported in this paper to study certain biological activities in soils, considering particularly soil samples collected from the "Maquilang Area". Recent investigators of the microbiological activities in soils contradict Liebig's idea that soil productivity is dependent on chemical processes. Experimentation and research conducted by various soil workers have shown considerable evidence that there is a definite correlation between nitrification and the crop producing power of soils. As a result of continuous cropping, especially without fertilization, a depressing influence on the nitrifying power of soils has been revealed by numerous investigators. Extensive investigation has also determined the existence of associative action among the different lower forms of life and between the bacteria and higher plants.

Factors influencing nitrification in soils

Nitrification may be defined as the conversion of ammonium compounds or nitrogenous organic matter into nitrates by microorganisms. Soil reaction is one of the most important factors that influence the process of nitrification in soils. Good drainage, frequent cultivation, adequate quantity of water, warm temperature and the presence of carbonate of lime are essential to the rapid pro-

¹Part of the material in this paper was reported in a thesis presented, October 1931, by the junior author for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture. Thesis No. 330; Experiment Station contribution No. 834. Received for publication June 30, 1932.

duction of nitrates in soils, Bear (1919). Excessive water, or the absence of nitrogen from any cause, tends to favor an anaerobic flora and may result in entirely stopping the nitrification process and in the reduction of such nitrates as may have been previously formed under more favorable conditions. The presence of organic matter affects nitrification. Difference in soil type, topography, climate, vegetation, microbiological soil population and cultivation may also influence the nitrification process in soils.

Review of literature

Early workers on nitrification studies in soils used the liquid culture method which afterwards was seriously criticised. Later, the soil method has been used more as it is claimed that nitrifying bacteria are more sensitive to organic matter in solution and in solution culture than in soils as media.

Literature on nitrification studies shows that in acid soils, ammonium sulfate, $(\text{NH}_4)_2\text{SO}_4$, is nitrified only to a small extent or not at all, particularly in those soils which are poorly buffered; but, in a neutral or alkaline soil particularly rich in organic matter, the ammonium sulfate is vigorously nitrified. Brown (1915 and 1916) in his work on the ammonifying and nitrifying power of several plots, treated and untreated, found some correlation of these processes with soil fertility. Results of analysis agreed with crop yields. Particular evidence of correlation between nitrification and soil productivity was likewise demonstrated by Noyes and Conner (1919).

Waynick (1918) and Waynick and Sharp (1919) called attention to the great variability of nitrate content and also to the extreme difference in nitrogen and carbon content in field samples of soils. Prince (1923) points to the variability in nitrate and variation in the nitrifying power of soils. It is of interest to note the work of Fraps (1921) the results of which suggest that nitrification may enable one to trace the effect of cropping upon nitrogen content of the soil.

Burgess (1918) in his work on Hawaiian soils of varying fertility, planted to sugar cane, reported that the degree of nitrification and nitrogen fixation were correlated with the fertility of the soil tested. Using the soil culture method in determining soil fertility he claimed that nitrification is by far the most accurate biological soil test perfected, for it ascertains the comparative crop producing power of arable soils. Waksman (1923) of the New

Jersey Experiment Station, points out that nitrification can yield information for the differentiation of soil fertility; that liming the soil stimulates the nitrifying capacity of the soil.

Lipman and Burgess (1915) in their work on California soils found that influence of biological phenomena indicated a significant difference between available and unavailable nitrogen. They found that ammonium sulfate is better nitrified in a neutral soil particularly rich in organic matter than in acid soils.

White (1915) emphasized the acid effect upon the soil of long continued use of sulfate of ammonia. He suggested that with the addition of sufficient lime the acid effect can be overcome. He further claimed that the nitrification that takes place in acid soils depends upon the degree of acidity. Recently, Brown and Aquino (1929) pointed out the effect upon the nitrifying power of soils of a definite amount of ammonium sulfate when used alone, and the effect of the same amount of ammonium sulfate used with a theoretical amount of calcium carbonate. They found that the latter treatment exerted a greater influence on the nitrifying power of soils than when ammonium sulfate was used alone.

Fred and Graul (1916) who worked on acid soils showed the favorable effect of nitrification not only upon ammonia salts but also upon organic nitrogen compounds. Organic matter was nitrified much quicker than ammonium sulfate, regardless of the source of nitrifying bacteria. In neutral soil the reverse is true. Erdman and Humfeld (1918), of the Iowa Experiment Station, obtained a definite correlation between the crop yields, the nitrifying power and the reaction of the soils after incubation, when tested by measuring the nitrification of ammonium sulfate. The nitrifying power of all soils was shown to be greater when calcium carbonate was used with ammonium sulfate in the nitrification test.

Brown and Houghland (1929) noted the significant effect of reaction of soil on its nitrifying power. If treated soils have more acid, nitrification will be reduced and fertilizers which would ordinarily stimulate nitrification will have no effect. These authors claim that acidic condition of the soils limits possible beneficial effects from treatments.

Alicante (1927) in his work on Philippine soils pointed out that soils in productive orchards showed higher nitrifying power than did soils from unproductive areas. He concluded that the physical properties of soils have an important bearing on their nitrifying efficiency; that is, soils containing higher percentages of clay nitrified either the original or the added nitrogen very poorly.

Abbot, Conner and Smalley (1913) reported nitrification in acid soils. Temple (1914) studied the rate of nitrification of ammonium sulfate with and without calcium carbonate. In the absence of calcium carbonate the amount of nitrate recovered from the treatment with ammonium sulfate was smaller than when calcium carbonate was applied.

Pañganiban (1915) found that different soils show different rates of nitrification even though they be chemically much the same. He attributed this fact to the influence of the present and preceding crops on the bacterial flora of the soil.

Aragon (1918) mentioned that calcium carbonate has a decided effect in increasing the rate of nitrification in the College Experiment Station soil which is Lipa clay loam.

Objects of the present work

The objects of this work were: (a) to study the nitrification in soils under different conditions; and (b) to study the nitrification process as affected by other characteristic features of the soil.

These nitrification studies were conducted in the laboratory of the Department Soils, College of Agriculture, University of the Philippines.

MATERIALS AND METHODS

The soil samples used in this study were collected from the "Maquiling Area", comprising portions of the municipalities of Alaminos, Bay, Calamba, Calauan, Los Baños, San Pablo, Santo Tomas and Tanauan in the provinces of Laguna and Batangas. This area was recently surveyed by a soil survey party under the direction of Dr. R. L. Pendleton, Head of the Department of Soils.

Apparatus and reagents

The pieces of apparatus used were glass tumblers, spatula, evaporating trays with 2-inches of sand, and a Dubescq. Bausch and Lomb colorimeter.

The reagents were (a) stock solution of ammonium sulfate $(\text{NH}_4)_2\text{SO}_4$, 1 cc. of which is equivalent to 15 mgm. nitrogen as ammonium sulfate; (b) stock solution of calcium carbonate (CaCO_3) , 1 cc. of which is equivalent to 105 mgm. of calcium carbonate; (c) phenoldisulfonic acid; (d) standard nitrate solution; (e) normal copper sulfate solution; (f) solid calcium hydroxide; (g) solution of ammonium hydroxide.

Preparation of soil samples. Each air-dry sample was pulverized and sieved through a one-half-millimeter mesh sieve.

Treatment of soil samples. Six 100-gram portions of each of the soil samples were weighed out into numbered tumblers and treated as follows:

Tumblers 1 and 2: nothing added (nitrification of soil's own nitrogen).

Tumblers 3 and 4: added 30 mgm. of nitrogen as ammonium sulfate (nitrification of ammonium sulfate in the soil).

Tumblers 5 and 6: added 30 mgm. of nitrogen as ammonium sulfate plus 210 mgm. of calcium carbonate (nitrification of ammonium sulfate in the presence of the theoretical amount of calcium carbonate necessary to neutralize all the acids formed from the complete oxidation of ammonium sulfate into nitric and sulfuric acids.)

The materials were thoroughly mixed with the soil by stirring with a spatula, after which distilled water was added to bring the soil to its optimum moisture condition (approximately 50 per cent of the saturation capacity). Each tumbler was covered with a tin cover and incubated in a dark chamber at room temperature (24–30°C.) for a period of twenty-eight days. Every ninth day each sample was again stirred and water equal to the amount evaporated was added. At the end of the incubation period the nitrate content of the cultures was determined and calculated to milligrams of nitrogen as nitrate per 100 grams of air-dry soil.

Determination of nitrates in the sample

In the determination of the nitrate content of soil the modified phenoldisulfonic acid (colorimetric) method, Emerson (1925) was used. The results of the duplicate determinations are presented in tabular form.

SUMMARY

1. Nitrification studies in soils were conducted with the use of soil samples representing the eighteen soil types which were found to occur in the "Maquiling Area."

2. The nitrification results showed that there was a distinct variation of the nitrate nitrogen contents of the different soil types.

3. All soil samples which did not receive any treatment differed in their nitrifying ability. The soils of the Calumpang series had a greater nitrifying power than any of the other series.

4. Soil samples of the same soil types differed in their nitrifying power.

5. In nearly all cases, the application of ammonium sulfate alone greatly stimulated the nitrification process in all samples.

6. An application of ammonium sulfate alone gave the soils of the Lipa series better nitrification than the soils of the Calumpang series under the same treatment.

7. In all cases the nitrification of ammonium sulfate was more marked with the addition of calcium carbonate in sufficient amount to neutralize the acids which are formed by the complete oxidation of ammonium sulfate.

8. Soil samples of the Calumpang series had the greatest nitrification with the application of ammonium sulfate plus calcium carbonate.

9. The different degrees of the nitrifying power of the soils used may be attributed to their variation in soils reaction, topography, soil type, vegetation, system of cropping and to the distribution of microbiological flora in the soil.

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NITRIFICATION RESULTS

SAMPLE NO.	DEPTH OF HORIZON	SOIL TYPE	MILLIGRAMS AS NITRATE IN 100 GRAMS AIR DRY SOIL ^c					
			Soil's own nitrogen		30-mgm. N as (NH ₄) ₂ SO ₄		30-mgm. N as (NH ₄) ₂ SO ₄ + 210 mgm. CaCO ₃	
				Average		Average		Average
	cm.	<i>I. Lipa Series</i>						
35-1 ^a	0-25	Lipa loam	0.43		2.62		3.32	
42-1	0-25	Lipa loam	0.81		1.57		3.14	
43-1	0-25	Lipa loam	0.54		2.57		2.76	
44-1	0-25	Lipa loam	0.74		2.43		3.63	
20-1	0-20	Lipa loam	0.18	0.54	1.56	2.15	2.06	2.98
41-1	0-25	Lipa loam, heavy	0.53	0.53	2.12	2.12	3.52	3.52
34-1	0-26	Lipa silt loam	0.63	0.63	3.22	3.22	3.71	3.71
26-1	0-25	Lipa clay loam	0.31		2.23		2.66	
28-1	0-25	Lipa clay loam	0.74		1.43		3.26	
29-1	0-20	Lipa clay loam	0.69		1.58		2.50	
3-1	0-18	Lipa clam loam	1.02		1.90		2.07	
47-1	0-15	Lipa clay loam	0.57		1.08		3.85	
6-1	0-25	Lipa clay loam	0.24		1.22		2.56	
40-1	0-20	Lipa clay loam	0.77	0.62	2.16	1.66	2.88	2.82
21-1	0-25	Lipa clay loam, eroded	0.16	0.16	1.27	1.27	2.13	2.13
31-1	0-25	Lipa light silty clay loam	0.31		2.50		3.22	
36-1	0-25	Lipa light silty clay loam	0.43		1.82		2.11	
37-1	0-25	Lipa light silty clay loam	0.48		2.36		2.69	
8-1	0-25	Lipa light silty clay loam	0.23		0.35		2.36	
18-1	0-25	Lipa light silty clay loam	0.32		2.02		3.05	
19-1	0-25	Lipa light silty clay loam	0.22		1.54		2.30	
25-1	0-25	Lipa light silty clay loam	0.34	0.33	1.53	1.73	2.45	2.60
33-1	0-25	Lipa light silty clay loam, rolling	0.35	0.35	3.10	3.10	3.28	3.28
		<i>II. Calumpang Series</i>	mgm.		mgm.		mgm.	
1-1 ^o	0-25	Calumpang clay	0.93		1.79		4.13	
5-1	0-27	Calumpang clay	1.21		1.70		4.22	
7-1	0-25	Calumpang clay	0.39		0.79		1.56	
12-1	0-25	Calumpang clay	0.75	0.82	2.84	1.78	3.85	3.45
2-1	0-30	Calumpang loam	0.68		1.28		2.51	
10-1	0-30	Calumpang loam	0.59		1.57		2.78	
10-2 ^b	30-65	Calumpang loam	0.36		1.80		2.79	
16-1	0-25	Calumpang loam	0.24	0.47	1.62	1.57	2.04	2.53
11-1	0-25	Calumpang clay loam	0.67		0.73		4.41	
46-1	0-25	Calumpang clay loam	0.67		1.54		3.23	
9-1	0-25	Calumpang clay loam	0.63		2.57		3.33	
32-1	0-18	Calumpang clay loam	1.25	0.81	4.22	2.27	4.55	3.88
15-1	0-25	Calumpang silt loam	0.23	0.23	1.40	1.40	2.33	2.33
14-1	0-25	Calumpang light silty clay loam	1.01	1.01	2.24	2.24	4.46	4.46

NITRIFICATION RESULTS (continued)

SAM- PLE NO.	DEPTH OF HORI- ZON	SOIL TYPE	MILIGRAMS AS NITRATE IN 100 GRAMS AIR DRY SOIL ^c					
			Soil's own nitrogen		30-mgm. N as (NH ₄) ₂ SO ₄		30-mgm. N as (NH ₄) ₂ SO ₄ + 210 mgm. CaCO ₂	
				Aver- age		Aver- age		Aver- age
	cm.	<i>III. Macolod Series</i>						
27-1	0-25	Macolod clay loam	0.87		2.76		3.17	
4-1	0-15	Macolod clay loam	1.02		1.66		3.47	
38-1	0-25	Macolod clay loam	0.41		1.02		2.92	
45-1	0-25	Macolod clay loam	0.02		....		0.63	
48-1	0-20	Macolod clay loam	0.71		0.89		4.40	
39-1	0-20	Macolod clay loam	0.47	0.58	1.13	1.49	3.00	2.93
23-1	0-25	Macolod clay loam, dark phase	0.15	0.15	0.36	0.36	0.42	0.42
24-1	0-30	Macolod clay loam, brown phase	0.23	0.23	0.82	0.82	1.87	1.87
		<i>IV. Ibaan Series</i>						
30-1	0-15	Ibaan clay loam	0.29		1.06		1.45	
17-1	0-25	Ibaan clay loam	0.26	0.28	0.80	0.93	2.04	1.75
		<i>V. Bay Series</i>						
13-1	0-18	Bay loam	0.80	0.80	2.71	2.71	2.74	2.74
		<i>VI. Puting Lupa series</i>						
22-2 ^b		Puting Lupa clay	....	....	....	....	....	....

^a "1" indicates surface soil.^b "2" indicates subsoil.^c Results given are the average of duplicates.

CONSTRUCTION AND OPERATION OF SILOS IN THE COLLEGE OF AGRICULTURE ¹

JOSÉ P. ESGUERRA
Of the Department of Animal Husbandry

WITH SIXTEEN TEXT FIGURES

A silo is a structure of special design used for storing succulent roughage. After a period of storage this roughage is called silage. This silage is used to feed farm animals during seasons when grass is not available or when the supply is limited.

In this paper the writer limits himself to the description of the construction of the concrete monolithic silo, which is a type made of concrete which was poured into forms for moulding or shaping. This kind of a silo has proved very satisfactory in the College of Agriculture. Live stock men who are considering building a silo may find the adoption of this type to their advantage.

Because of the limited pasture areas in the College of Agriculture a silo had long been needed. As the animals in the department increased, this need became more pressing each year.

KINDS AND FORMS OF SILOS

There are several kinds of silos. Some of the common ones are the concrete, staves, wooden-hoop, brick and stones. In the College after due consideration and study it was decided to build a concrete silo. This kind was selected principally because it would be more durable and would stand the destructive force of typhoons and earthquakes better than the staves or wooden-hoop type. It was also believed that the concrete silo would be somewhat cheaper and easier to build in the College than any of the other kinds on account of the availability of materials and the past experience with concrete work.

The rigidity of the wall is a prime necessity in a silo. A round silo is preferred to rectangular, octagonal or any other form because the side pressure is uniform and it preserves the silage well.

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² Thanks are due Mr. J. P. Mamisao of the Department of Agricultural Engineering for preparing the drawings in final form for engraving.

THE COLLEGE SILOS

The College of Agriculture has two silos, both of the concrete monolithic type. The first one was completed early in March, 1928. It is 27 feet (8.23 meters) high from inner base and has an inside diameter of 8 feet (2.44 meters). Its capacity is estimated to be 22 tons.

It was filled for the first time with corn on August 24, 1928. As the silo was still in the experimental stage it was decided not to fill it to capacity. The corn was left in the silo for 7 months and 9 days. On April 2, 1929, the silo was opened. The silage obtained from this attempt weighed seven and one-half tons and was fed with very satisfactory results to 8 dairy cattle and 12 milk carabaos from April 2 to May 26, 1929, or a period of nearly two months.

The silo was refilled to full capacity on August 7, 1929, and opened March 1, 1930. The total amount of silage obtained from the second filling was over 18 tons. It was fed to dairy animals for nearly four months (March 1, to June 26, 1930).

The first silo proved so successful that in June, 1930, the construction of a second silo was begun. This silo is a little larger than the first one, measuring 31 feet (9.45 meters) high and with an inside diameter of 10 feet (3.05 meters). The estimated capacity is 51 tons. It will be noted that while the volume of the small silo is 1,357 cubic feet and the larger one is 2,434 cubic feet, the capacity of the latter is calculated to be more than double that of the former. The reason is that the larger the diameter of the silo the heavier the mean weight of the silage becomes per unit volume. The experience of the department in the construction of these silos is given in the following pages.

HOW THE COLLEGE SILOS WERE CONSTRUCTED

The foundation

Marking off the foundation. (See fig. 1.) The foundation of the silo was marked off on the selected site. A piece of board *a*, $2'' \times 2'' \times 11\frac{1}{2}'$, one end of which was sharpened and the other end made cylindrical, was driven about six inches in the ground at the center of the proposed base of the silo. Through one end of another piece of board *b*, $2'' \times 4''$ and with a length about equal to the distance from the center stake to the outside boundary, a hole was bored. The hole was made large enough to allow the piece *b* to turn on *a*. The board *b* turning on board *a* was used as a measure in describing

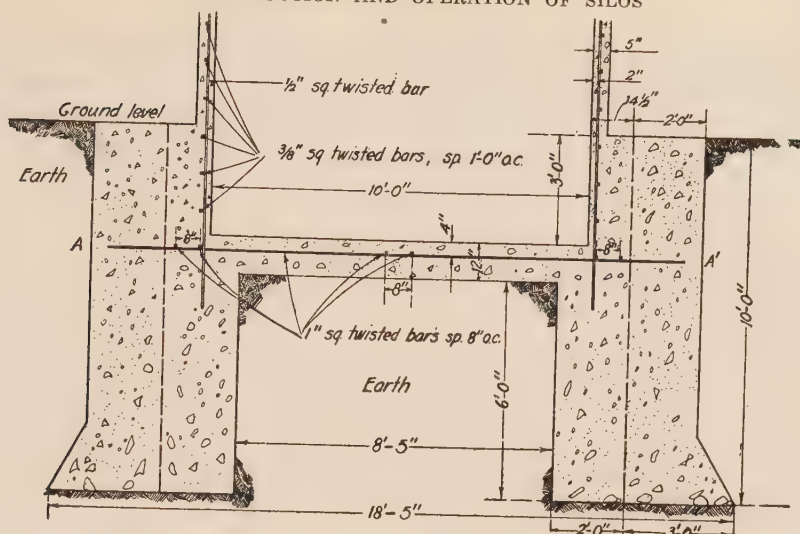
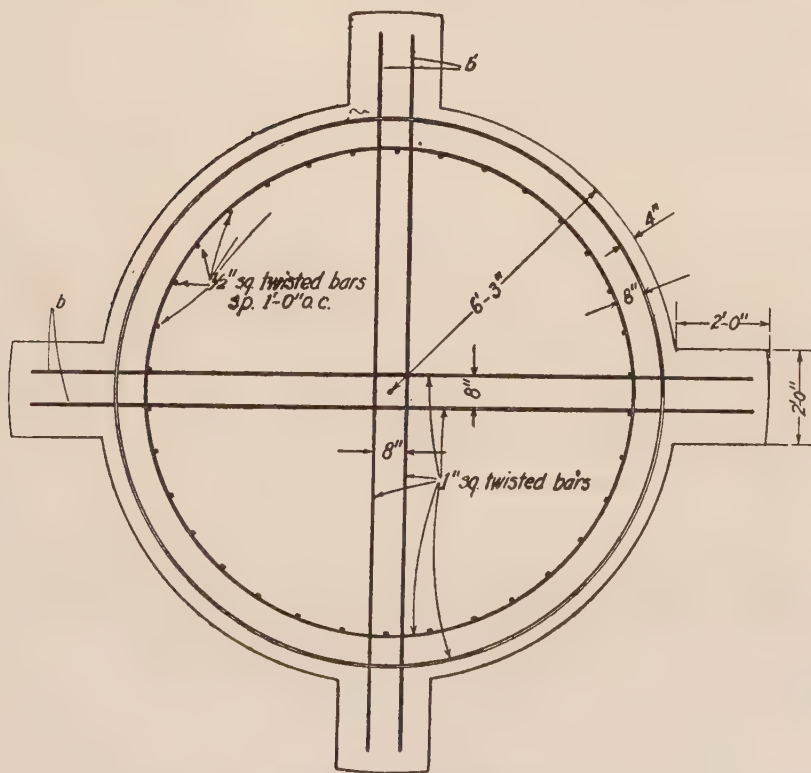


Fig. 3.—Showing the foundation in a loose soil.



Section A-A' of Fig 3.

Fig. 4.—Top view of the foundation before the reinforcing iron rods are buried in the concrete.

the circumference of the foundation. A sharpened stake or marker *c* was nailed at the other end of *b*. To keep the piece in a horizontal position, a level *e* was placed on its top and an extension marker *d* was used as the circle was being drawn on the uneven ground.

Digging the foundation. (See fig. 2 and 3.) After marking the foundation, excavation was begun inside the circle. It was necessary to dig down till a firm layer was reached. So far as possible the side of the hole was made plumb. Adobe was not struck until 12 feet below the surface. The base was widened as shown in figure 3 because the surface soil was very loose. To make the silo more stable four additional excavations, each two feet by two feet by the depth of the foundation, were made. (See fig. 4.) Figure 2 would have been the form of the foundation had adobe rock been hit at about six feet deep.

Filling the foundation. The bottom of the excavated area was covered with a layer of small pieces of rock (crushed boulders). On the top of this layer concrete was poured. To economize in the use of concrete in filling up the foundation, rocks of convenient size collected from Molawin Creek were used as fillers. (See fig. 3.) The fillers added weight to the foundation, making it more stable.

How the forms were made

Two plain galvanized iron sheets, gage No. 22, 36 inches wide and 8 feet long, were used to make the quarter forms. This material was used because it is light, easily made into forms which can be used in the construction of other silos of the same diameter. As the silo is cylindrical, two circles, one the circumference of the inside and one that of the outside of the silo were made out of 1" \times 6" lumber. Sixteen pieces make a complete circle. To these wooden circles the iron sheets were nailed, making two cylinders.

Laying out the patterns for the iron sheets. (See fig. 5 A.) A clean level surface with a circular area greater than the area of the base of the silo was selected. A center *O* was located in it and two circles having a diameter of 8 feet and 8 feet and 5 inches, respectively, were described. This was done with the use of a piece of board 1" \times 2" \times 9' having a 5-inch nail driven in one end and two 2-inch nails in the other end. The big nail was used as the pivot and the other two nails described the circumferences of the circles. The circles were then divided into 16 equal parts. Patterns were made to fit the arc in each part.

A piece of board *d*, 1" \times 6" was laid on one arc with an edge touching the middle point of the arc. The board *d* was nailed to the floor and on it the arc of the inner circle was inscribed. Another piece of board *e* having the same dimensions as *d* was used in a like

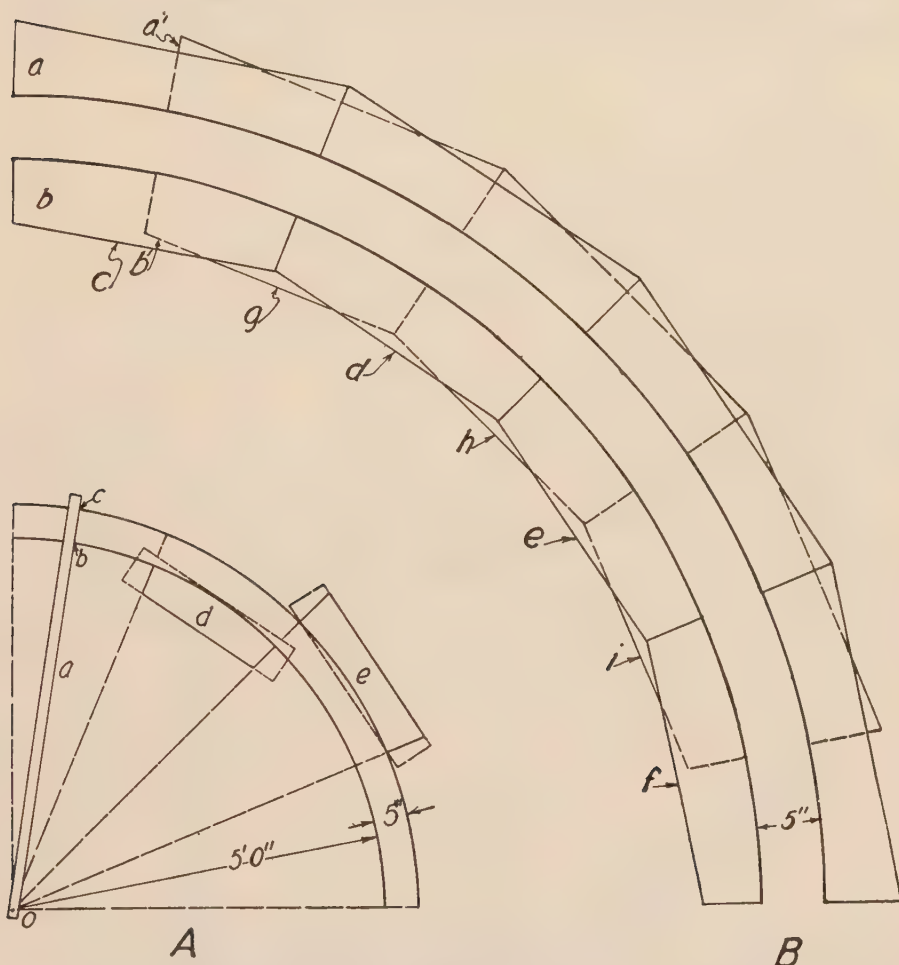


Fig. 5.—(A)—How the patterns were laid out: (*o*) center of circle; (*a*) radius board; (*b*) inside diameter of the proposed silo; (*c*) outside diameter of the proposed silo; (*d*) one-sixteenth pattern for the inside form of the wall; (*e*) one-sixteenth pattern for the outside form of the wall.

(B)—Showing the plan of arranging the patterns (one-fourth section of the circle): (*a'* and *b'*) patterns three inches shorter than the others; (*a* and *b*) patterns in full length; (*c d e f*) first layer of patterns; (*g h i*) second layer of patterns.

manner for the outside form, only the shape of the patterns was reversed. The patterns will serve to make the 128 pieces needed to build four circles, two for the inside and two for the outside forms.

Arrangements of patterns. (See fig. 5 B.) The supporting circles in both the inside and outside forms were made in two layers, as shown in figure 5 B. Letters *a* and *b* represent the first layer and *a'* and *b'*, the second. After the patterns were made the first layer *c, d, e, f*, was laid off to fit the circles previously drawn on the level surface. On the top of this layer the second

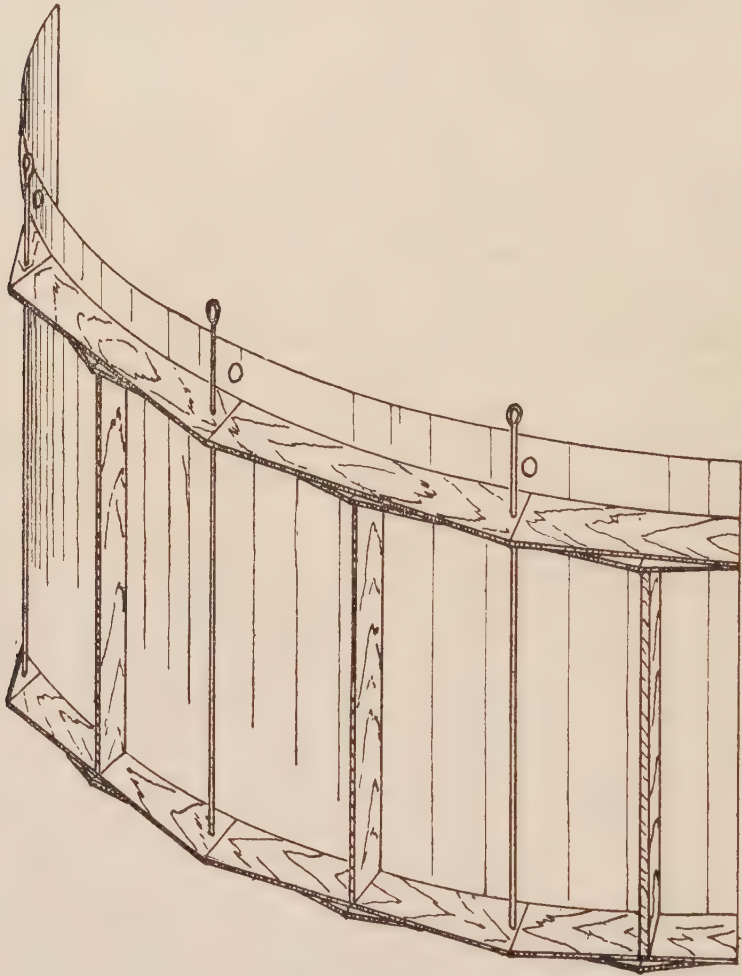


Fig. 6.—One-fourth section of the outside form for the wall.

layer of patterns *g, h, i, j*, was laid. This process was repeated with the outside supporting circles. In making the circle, note that it will be divided into four parts, so in nailing the pieces together the proposed joints should not be nailed firmly. Every quarter section of the circle will hold four pieces of the patterns to one layer.

Building the forms. (See fig. 6 and 7.) One one-quarter section of the supporting circles of the inside form was made about three inches shorter than the other three so that it could be made to slide when it was removed from the wall. That is, patterns *b* and *b'* were each cut three inches shorter than the others so that when the forms were fitted together a three-inch gap was created between the first and fourth forms, *a b a' b'* of the first quarter form

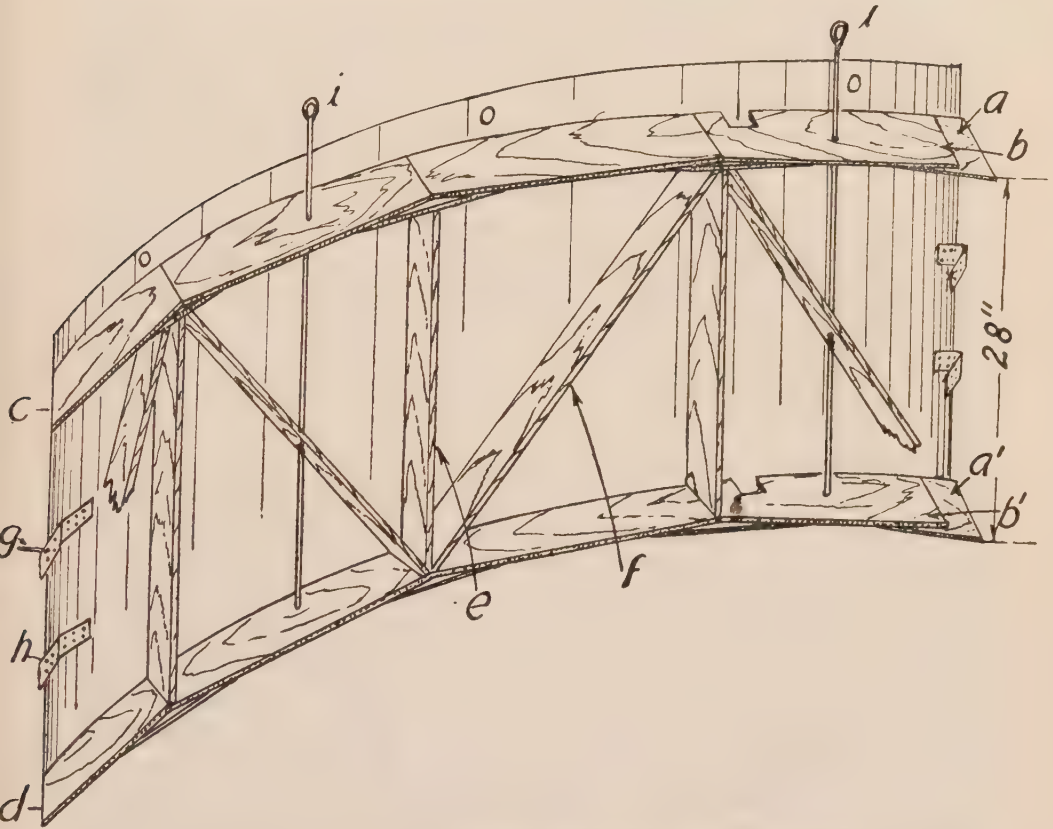


Fig. 7.—One-fourth section of the inside form for the wall: (*b* and *b'*) patterns cut three inches at one end; (*a* and *a'*) patterns in full length; (*c*) top circle after patterns were arranged; (*d*) bottom circle after patterns were arranged; (*e*) studs supporting top and bottom circles; (*f*) braces; (*g*) bolt connected to the lug; (*h*) lugs; (*i*) hoisting rod.

and the last four patterns of the fourth quarter form. The top and bottom circles *c* and *d* were placed directly one over the other with a distance in between of about 28 inches. They were supported by studs *e* and braces *f* to prevent the iron sheets from bulging.

The iron sheets were nailed securely on each quarter circle and on the studs. On one end of the supporting quarter circle the iron sheets covering one section of the form protruded about eight inches. This was done to allow for an overlap on the other form section.

Each quarter section was provided with lugs *h* and bolts *g*, the former being of mild flat iron, $\frac{1}{4}$ " \times 2" \times 8", riveted on the end of the galvanized iron sheets. The pairs of lugs were necessary to hold one section of the form at each joint.

Each quarter section of the form was provided with two pieces of iron rod *i* fastened through the supporting circles with an eye on the upper end to facilitate raising. Iron slots with eyes riveted to the upper end of each section would serve the same purpose.

Building the scaffold

Before the forms were set in place the scaffold shown in figure 8 was constructed. As the figure shows, the silo was built outside the scaffold. The scaffold was necessary in raising and supporting the forms and for the workmen to stand on while working. The silo is 27 feet high from the bottom; the middle upright *a* of the scaffold was 32 feet long. It is difficult to get commercial lumber of this length so 8 pieces 4" \times 4" \times 18' long were used. Four of the pieces were joined together with bolts, thus making a unit. The two units were joined end to end. The four-sided upright was then shaved and planed into an eight-sided, or octagonal column. In the center of the top end of this column a two-inch hole about 8 inches deep was bored. In this hole a cylindrical piece of wood of the same diameter as the hole and about 14 inches long was driven. To the protruding six inches of this piece a scantling *b* with a 2½" hole through one end was fastened. On the other end of the scantling, two pieces of one-half inch mild round steel *c* and *d* were bolted on the upper side; in the free ends of each piece were eyes.

The lower end of the octagonal upright was at the center of the floor of the silo. To it were connected eight lateral uprights *e*, 2" \times 4" \times 27' long. These uprights were arranged in a circle around the middle or octagonal upright at about equal distances apart, and were connected to it by means of supports *f*. To provide room for raising and removing the forms, an 8-inch space between the uprights and the proposed wall of the silo was left.

Reinforcing

A silo is subjected to an outward pressure by the silage which is a heavy material. A concrete structure in itself has a very low

tensile strength. These two conditions working together make the reinforcing of the silo an absolute necessity. Besides the pressure of the silage within, the silo must also withstand pressure from without.

The main body and part of the foundation of College silo were reinforced. After the foundation had been filled up to four inches below the surface of the floor, two, one-inch twisted iron rods *a*, (fig. 4) were placed about eight inches apart in a circle and then two other pieces *b* and *b'* were placed crosswise. The iron pieces were tied snugly together. Concrete was then poured on filling up the remaining four inches of the thickness of the floor. While the concrete was still soft the reinforcement for the main body of the silo was inserted. This was done by setting the one-half inch twisted iron rods vertical at a distance of about eight inches apart. These uprights were held together by three-eighths inch twisted iron rods placed in a circular form at right angle to the uprights. They were also set one foot apart from the bottom to the top of the uprights. Old woven wire fencing was tied around the iron rods to further reinforce the silo against lateral stress. (See fig. 9.)

Setting the forms

After filling the foundation to the floor of the silo with concrete the inside form was set as shown in figure 9, letter *a*, and when the inside wall was constructed to the surface of the ground, the outside form was set in position as shown in figure 10, letter *b*. In order to get the exact thickness of the wall, 1" \times 1" \times 5" pegs (five inches is the thickness of the wall of the silo) were placed in between the inside and outside forms at convenient distances to hold the forms in place. This was done only while constructing the lower part of the wall of the silo. At the top edge of the forms a number of spacing blocks (fig. 11) were inserted to keep the wall in uniform thickness. As the forms were filled up with the concrete the spacers that had been placed in between the forms were removed one by one.

In setting the forms care was taken that the top edge was level and the side plumb. When filling in layer after layer in the form, care was taken to keep the form in exact position because if one side were higher than the other, the silo would not be circular, the uniformity in thickness would not be maintained nor would the structure stand exactly perpendicular to the ground.

To keep the forms plumb, pieces of lumber 2" \times 4" \times 18' (fig. 10, *c*) were used to hold them in place. These pieces had five-

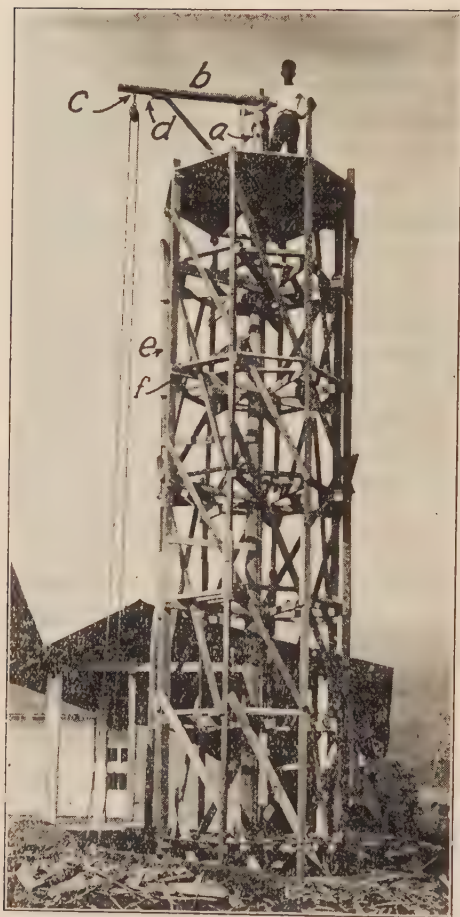


Fig. 8.—The scaffold: (a) middle upright; (b) scantling for hoisting forms; (c and d) iron rods with an eye each where pulley is attached; (e) lateral uprights; (f) pieces of board connecting lateral uprights to the middle upright.

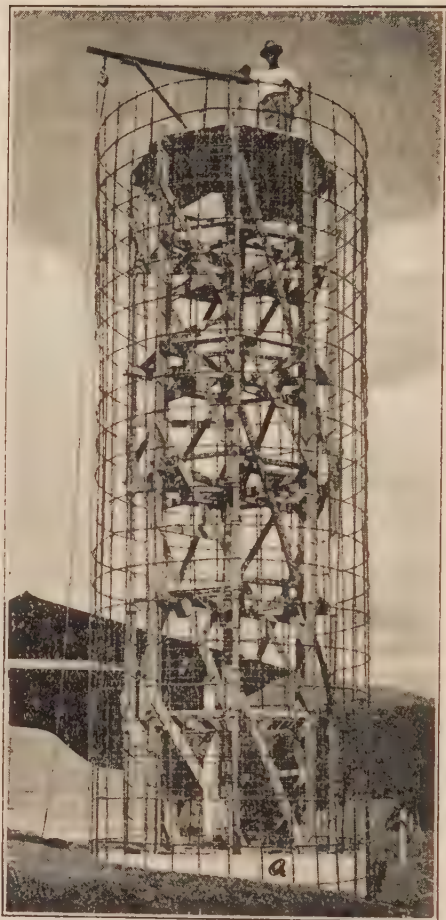


Fig. 9.—Iron rods and woven wire fencing were used as reinforcing materials: (a) inside form.

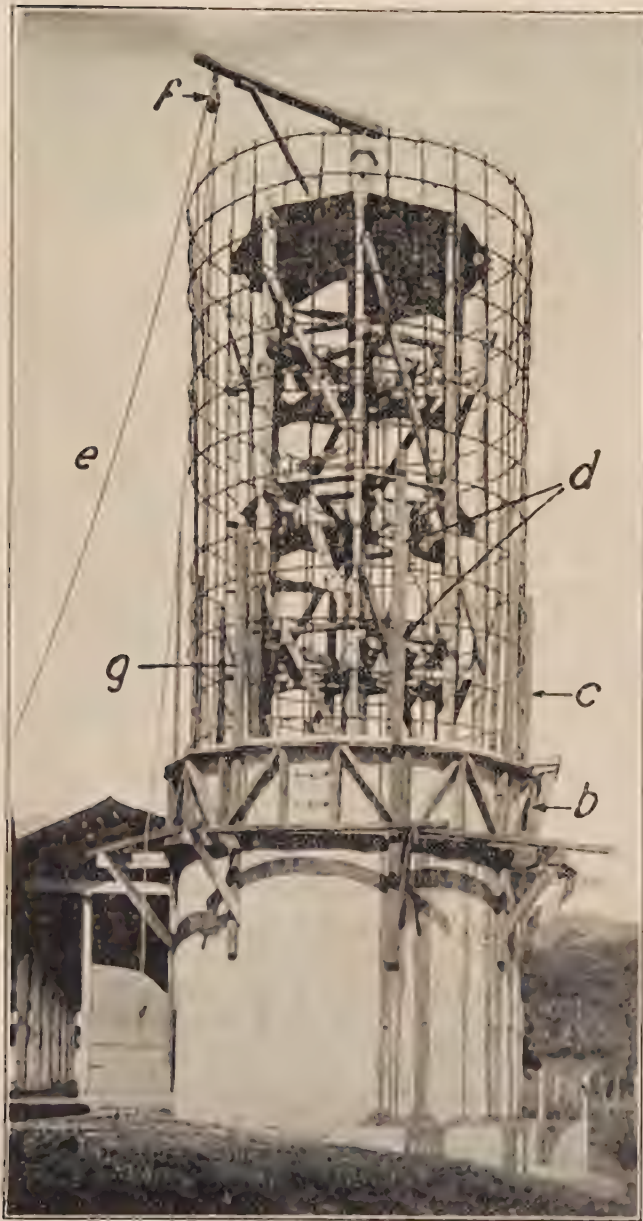


Fig. 10.—A silo form in position: (b) outside form; (c) board to hold the forms in place; (d) slots on the board; (f) pulley; (e) hoisting rope.

eighths inch slots *d* at intervals of about 32 inches, through which one-half inch bolts could pass. The iron sheets had slots of the same size on the top and at the bottom, each slot being two inches from the edge. The pieces of lumber in the inner forms were directly opposite the pieces in the outer forms, as they were bolted together with the forms in between.

After the forms were set in place and properly bolted together, spacing blocks (fig. 11) were placed at the top edge at proper intervals to keep the forms the same distance apart. Then the forms were filled up with concrete.

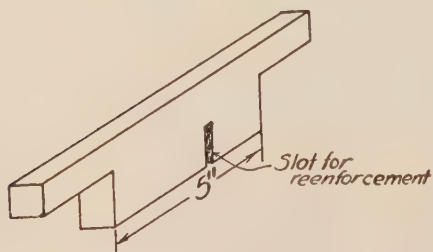


Fig. 11.—Spacer.

To loosen them, the bolts were turned before the concrete set. After 24 hours the bolts were removed and the forms raised for another layer. Special care was taken that the bottom ends of the scantlings holding the forms together (fig. 10, letter *g*) were one or two layers below the forms and properly bolted to

the concrete. These ends kept the form plumb.

As the wall of the silo became higher and higher, rows of bolt holes on the concrete were left. These holes were needed in constructing the platform on which the men worked during the building of the silo (fig. 15.) After the silo was completed these bolt holes were plugged with concrete.

Materials for concrete

Cement. "Apo" cement was used in the construction of the silo. This cement can be purchased in barrels. In buying cement one should be sure that the material is fresh. It must not be stored too long, or kept where it can readily absorb moisture. Under either condition it becomes hard and unfit for use.

Sand. The sand used was coarse and free from clay and vegetable matter. To be sure that the sand was free from impurities it was passed through water.

Crushed rock or gravel. Because of its hardness and the angular shape of the pieces, crushed rock was found to be the best material to mix with cement and sand. Very coarse gravel taken from the river could have been used but there was a possibility that the mixture would not be as strong as with the crushed rock because of the smoothness of the water-washed pieces.

For the sake of economy, two sizes of crushed rock was used; namely, "Class B" which could pass through a two and one-half inch mesh, for the foundation, and "Class A" which could pass through a three-fourths inch mesh, for the wall. "Class A" is more expensive material than "Class B".

Water. So far as could be determined, the water used in mixing was free from salts and acids.

Proportion and measuring

In mixing, two different proportions were used. For the foundation, the proportion was 1:5:7 (one part cement, five parts sand and seven parts crushed rock). For the wall the proportion was 1:3:5 (one part cement, three parts sand and five parts crushed rock).

Filling the forms

To insure stability of the form only a few inches in depth were filled at a time. During the filling the concrete was tamped with a piece of board to exclude all air spaces which if left would make cavities in the wall. The wall should be perfectly solid. When the frames were raised higher, the wall they had covered was still damp. To prevent cracking because of hastened drying in the sun and wind, the wall was sprinkled with water several times a day, for three or four days.

When the form was filled for the day, special care was taken to leave a rough surface on the top. Then in resuming the filling the following day the top surface was coated with mortar (one part cement and three parts sand) so as to make a good union between courses.

Raising the forms

A pulley *f* was hung in the eye of the scantling (fig. 10). Using a rope of convenient size fastened through the eyes of the iron rod *i* (fig. 6 and 7), the forms were raised with this pulley.

As soon as the forms reached their new position they were temporarily held in place by bolting them through the holes on the wall until all the sections had been raised. All form sections could be conveniently raised by the hoisting rope and pulley. The scantling to which the pulley was attached could be turned around and placed directly opposite the section to be raised. (See fig. 9 and 10.)

When all the sections had been raised they were fitted in position.

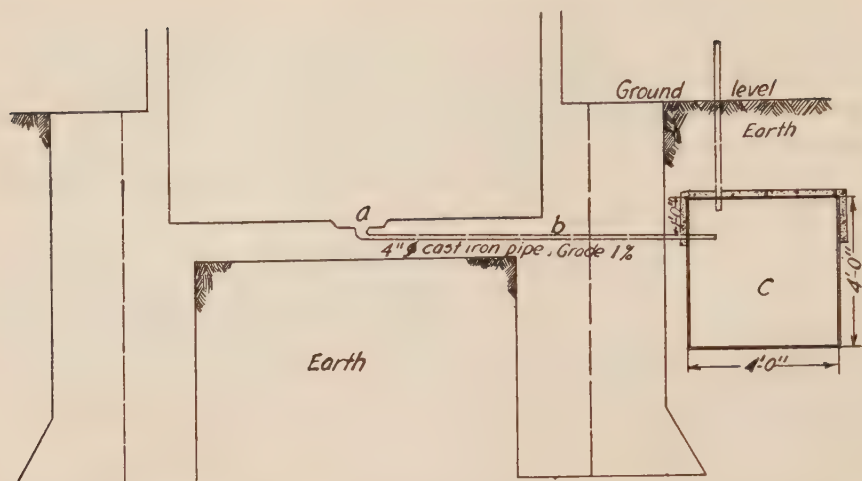


Fig. 12.—Sectional view of silo and cesspool; (a) drain hole; (b) drain pipe; (c) cesspool.

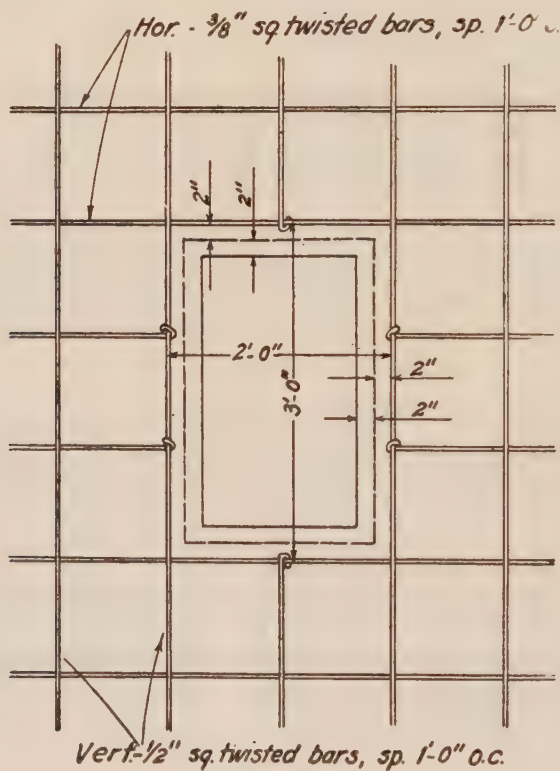


Fig. 13.—Reinforcement of the door.

Doors

The plan for reinforcement for the door is shown in figure 13. A form for the door (fig. 14A) was set in between the inside and outside forms. It was made in such a way that when the wall was completed a two-inch space was formed around the inside of the opening. The top and the side of the form were slightly tapering and the lumber used was well dressed.

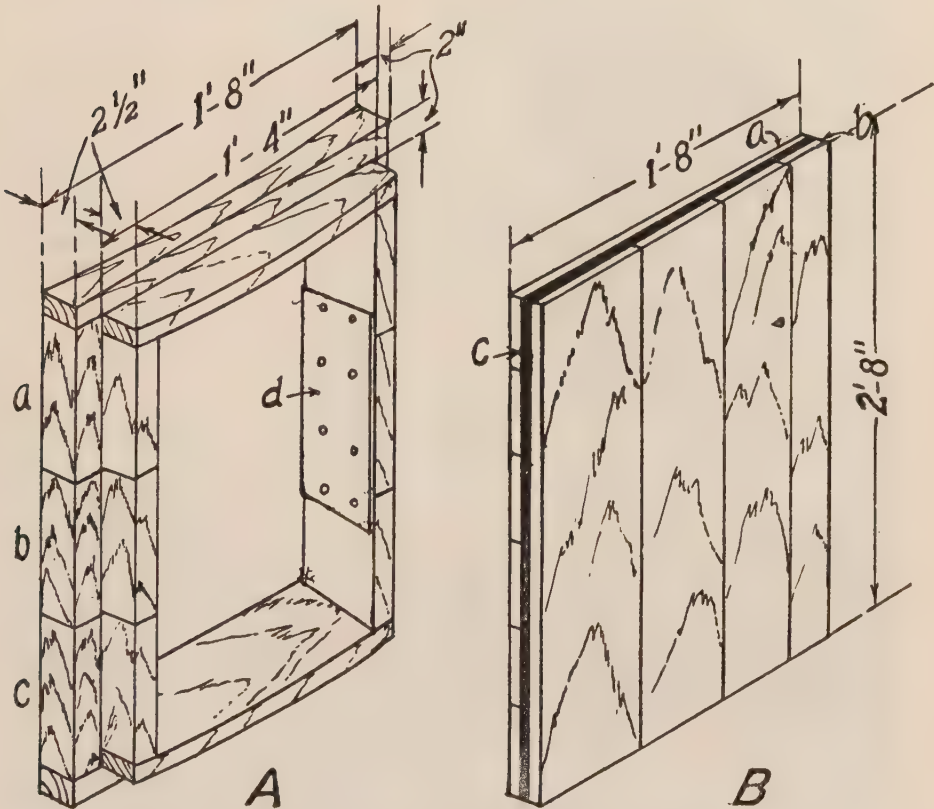


Fig. 14.—(A)—Door form: (a) (b) (c) three divisions of the form; (d) A board holding a, b and c together.

(B)—Door: (a and b) two thicknesses of the door; (c) plaster board between the two thicknesses of board.

The form, well greased, was placed in position, loose at the bottom so as to admit the concrete at the base of the opening.

In order to facilitate the removal of the form after the concrete had been poured in and dried it was divided with a saw into three parts a b c (fig. 14A). Another piece of board d was nailed to the parts, to hold them together.

Figure 14B represents the wooden door. When the silo was put to use this door was set in and was held in place by the pressure of the silage.

The door was made out of two layers of floor lumber, *a* and *b*, with plaster board "Certainteed", *c* between, as shown in figure 14B.

This kind of a door will exclude the air and reduce the danger of the silage spoiling.

Floor and drainage

The floor was made of the mixture used for the foundation; its surface was coated with mortar, a mixture of one part cement and three parts sand. In the center of the floor a cavity 6 inches deep and 12 inches square at the surface and slightly tapering towards the bottom was made. This cavity (fig. 12*a*) was connected with a soil pipe *b* attached to one side of the drainage. The soil pipe was four inches in diameter and was buried two inches below the surface of the floor. It was placed in position before the wall and the floor of the silo were made.

Because the floor of the silo was three feet below the surface of the ground, it was difficult to drain off the excess liquid of the silage. To

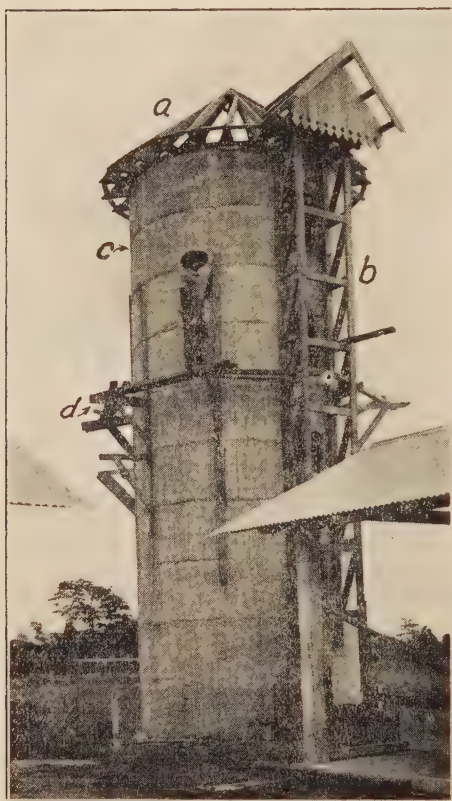


Fig. 15.—Showing the skeleton of the roof and chute, and union between courses of concrete and the platform: (*a*) skeleton of the roof; (*b*) skeleton of chute; (*c*) union between courses of concrete; (*d*) platform.

facilitate drainage, a cesspool *c*, four feet deep and four feet square, was dug a few feet from the silo (fig. 12).

Roof, chute and ladder

As soon as the last layer of the wall was completed, 32 one-half inch bolts, 12 inches long were set in the top allowing five in-

ches to project outside. These bolts were placed before the concrete set. They were used for holding the plates on which the rafters rested.

Figure 15 shows the skeleton of the roof *a*, and the chute *b*. The roof was provided with an opening *a* to admit the blower pipe



Fig. 16.—The blower-cutter, mounted and showing engine: (*a*) hole through which blower pipe passes; (*b*) blower-pipe; (*c*) chute; (*d*) blower-cutter.

that is used in filling the silo (fig. 16). In taking the silage from the silo, loss can be prevented by inclosing the doors with a chute *c*. A ladder can also be placed inside the chute.

Coating the wall

To plug up the pores and to make the wall air-tight and to improve the appearance, the concrete part of the silo was given a coat of cement wash. The coat of cement wash should be put on just after the forms have been raised up, before the concrete dries out. If the wall is drenched first with water the cement coat can be put on after the wall is completed.

BILL OF MATERIALS

One who desires to build a silo will naturally want to know the cost of the structure. Also, what materials and the quantity of each will be required. The labor cost is another natural question.

These questions are answered approximately by the data shown in the two bills of materials here given.

It should be borne in mind that the cost of the silo herein given is approximate as the cost of materials, transportation, and labor vary according to place, season of construction, and market conditions.

BILL OF MATERIALS FOR A SILO 8 FEET IN DIAMETER AND 27 FEET HIGH,
WALL 5 INCHES THICK

30.5 barrels	— cement "Apo" @ P 5.88.....	P170.80
18.0 cu. m.	— crushed rock "Class B".....	30.00
7.0 "	— crushed rock "Class A".....	22.40
14.5 "	— sand	14.50
8.0 sheets	— plain G. I. ^a 8'×22 ga.	27.70
8.0 "	— plain G. I. ^a 8'×26 ga.	17.60
30.0 pieces	— twisted bars 1/2"×26'	28.85
28.0 "	— twisted bars 3/8"×30'	19.50
4.0 "	— twisted bars 1"×30'	11.52
1.0 piece	— round mild bar 1"×8'	1.40
6.0 pieces	— round mild bars 1/2"×12'	1.92
1.0 piece	— flat iron 1/4"×2"×16'	0.53
1.0 "	— flat iron 3/8"×3"×8'	1.62
1.0 roll	— woven wire fencing	22.50
20.0 pieces	— bolts with nuts and washers 3/4"×10"	2.00
16.0 "	— bolts with nuts and washers 1/2"×8"	0.96
8.0 "	— bolts with nuts and washers 1/2"×12"	0.56
8.0 "	— bolts with nuts and washers 1/2"×15"	0.72
3.0 "	— soil pipe 4"×5'	5.10
2.0 kgm.	— common wire nails 4"	0.30
2.0 "	— common wire nails 3"	0.36
3.0 "	— common wire nails 2"	0.54

^a G. I. = galvanized iron.

4.0 pieces	— guijo, 3"×5"×14'	.....	29.16
7.0 "	— guijo, 3"×5"×12'	.....
12.0 "	— apitong, 2"×4"×14'	.....
2.0 "	— apitong, 4"×4"×14'	.....
2.0 "	— apitong, 2"×4"×16'	.....	31.66
4.0 "	— apitong, 2"×4"×10'	.....
30.0 "	— apitong, 1"×6"×12'	.....
8.0 "	— almon, 4"×4"×16'	.....
18.0 "	— almon, 2"×3"×12'	.....
28.0 "	— almon, 2"×4"×14'	.....	61.56
12.0 "	— almon, 1"×6"×14'	.....
16.0 "	— almon, 1"×6"×16'	.....
Total			P498.76
Transportation charges (approximate)			60.00
Total labor charges			593.00
Total cost of the silo.....			P1,151.76

BILL OF MATERIALS FOR A SILO 10 FEET IN DIAMETER AND 31 FEET HIGH,
WALL 5 INCHES THICK

37.5 barrels	— cement "Apo" @ P5.88	P220.50
21.0 cu. m.	— crushed rock @ P2.50 "Class B"	52.50
11.0 "	— crushed rock @ P3.20 "Class A"	35.20
18.5 "	— sand @ P1.00	18.50
8.0 sheets	— plain G. I. ^a 9'×22 ga.	30.40
12.0 "	— plain G. I. ^a 9'×24 ga.	30.60
40.0 pieces	— twisted bars 1/2"×30'	32.00
30.0 "	— twisted bars 3/8"×30'	14.00
4.0 "	— twisted bars 1"×30'	12.34
4.0 "	— round mild bars 1/2"×16'	1.00
1.0 piece	— round mild bar 1"×10'	1.50
1.0 "	— flat iron 1/4"×2"×16'	0.60
1.0 "	— flat iron 1/2"×3"×8'	1.98
1.0 roll	— woven wire fencing—50 meters long.....	19.50
20.0 pieces	— bolts with nuts and washers 1"×10"	2.55
16.0 "	— bolts with nuts and washers 1/2"×8"	0.90
8.0 "	— bolts with nuts and washers 1/2"×15"	2.55
8.0 "	— bolts with nuts and washers 1/2"×12"	0.56
3.0 "	— soil pipe 4"×5'	7.32
2.0 kgm.	— common wire nails 4"	0.26
3.0 "	— common wire nails 2"	0.42
3.0 "	— common wire nails 3"	0.39
4.0 pieces	— guijo, 3"×5"×12'	} 30.40
8.0 "	— guijo, 3"×5"×12'	

^a G. I. = galvanized iron.

6.0	pieces	—	apitong, 2"×4"×16'	}	36.22
13.0	"	—	apitong, 2"×4"×14'	.....	
4.0	"	—	apitong, 2"×4"×10'	.....	
2.0	"	—	apitong, 4"×4"×14'	.....	
32.0	"	—	apitong, 1"×6"×12'	.....	
12.0	"	—	almon, 1"×6"×14'	}	81.68
32.0	"	—	almon, 2"×3"×12'	.....	
12.0	"	—	almon, 2"×3"×14'	.....	
8.0	"	—	almon, 4"×4"×18'	.....	
32.0	"	—	almon, 2"×4"×16'	.....	
16.0	"	—	almon, 1"×6"×16'		
Total						P633.87
Transportation charges (approximate)						75.00
Total labor charges						666.34
Total cost of the silo.....						P1,375.21

MATERIALS NEEDED FOR A SILO 8 FEET IN DIAMETER 27 FEET HIGH,
WALL 5 INCHES THICK—GIVEN IN DETAIL

30.5	barrels	—	sand
18.0	cu. m.	—	crushed rock "Class B"
7.0	"	—	crushed rock "Class A"
14.5	"	—	cement "Apo"

Reinforcing materials

4	pieces	—	twisted bars 1"×30'
30	"	—	twisted bars 1/2"×26'
28	"	—	twisted bars 3/8"×30'
6	"	—	round mild bars 1/2"×12'
1	piece	—	flat iron 1/4"×2"×16'
1	roll	—	woven wire fencing, 50 meters long

Materials for forms

8	sheets	—	plain G. I. ^a 8'×22 ga.
12	pieces	—	almon, 1"×6"×14'
8	"	—	almon, 2"×3"×12'
10	"	—	almon, 2"×3"×14'

Materials for scaffold

8	pieces	—	almon, 4"×4"×16'
28	"	—	almon, 2"×4"×14'
10	"	—	almon, 2"×3"×12'
16	"	—	almon, 1"×6"×16'
20	"	—	bolts 3/4"×10"

^a G. I. = galvanized iron.

Materials for the roof

8 sheets	— plain G. I. ^a 8' × 26 ga
1 piece	— round mild bar 1" × 8'
1 "	— flat iron 3/8" × 3" × 8'
8 pieces	— bolts, 1/2" × 15"
16 "	— bolts, 1/2" × 8'
8 "	— bolts, 1/2" × 12"
4 "	— guijo, 3" × 5" × 14'
7 "	— guijo, 3" × 5" × 12'
2 "	— apitong, 2" × 4" × 16'
6 "	— apitong, 2" × 4" × 14'

Materials for chute

2 pieces	— apitong, 4" × 4" × 14'
6 "	— apitong, 2" × 4" × 14'
4 "	— apitong, 2" × 4" × 10'
30 "	— apitong, 1" × 6" × 12'

Miscellaneous materials

3 pieces	— soil pipe 4" × 5'
2 kgm.	— common wire nails 4"
2 "	— common wire nails 3"
3 "	— common wire nails 2"

MATERIALS NEEDED FOR A SILO 10 FEET IN DIAMETER 31 FEET HIGH,
WALL 5 INCHES THICK—GIVEN IN DETAIL

37.5 barrels	— cement
21.0 cu. m.	— crush rock "Class B"
11.0 "	— crushed rock "Class A"
18.5 "	— sand

Reinforcing materials

4.0 pieces	— twisted bars 1" × 30'
40.0 "	— twisted bars 1/2" × 30'
30.0 "	— twisted bars 3/8" × 30'
4.0 "	— round mild bars 1/2" × 16'
1.0 "	— flat iron 1/4" × 2" × 16'
1.0 roll	— woven wire fencing, 50 meters long

Materials for forms

8.0 sheets	— plain G. I. ^a 9' × 22 ga.
12.0 pieces	— almon, 1" × 6" × 14'
8.0 "	— almon, 2" × 3" × 12'
12.0 "	— almon, 2" × 3" × 14'

^a G. I. = galvanized iron.

Materials for scaffold

8.0 pieces	— almon, 4" × 4" × 18'
32.0 "	— almon, 2" × 4" × 16'
24.0 "	— almon, 2" × 3" × 12'
16.0 "	— almon, 1" × 6" × 16'
20.0 "	— bolts, 1" × 10"

Materials for roof

12.0 sheets	— plain G. I. ^a 9' × 24 ga.
1.0 piece	— round mild bar 1" × 10'
1.0 "	— flat iron 1/2" × 3" × 8'
8.0 pieces	— bolts, 1/2" × 15"
8.0 "	— bolts, 1/2" × 12"
16.0 "	— bolts, 1/2" × 8"
4.0 "	— guijo, 3" × 5" × 14'
8.0 "	— guijo, 3" × 5" × 12'
4.0 "	— apitong, 2" × 4" × 16'
8.0 "	— apitong, 2" × 4" × 14'

Materials for chute

2.0 pieces	— apitong, 4" × 4" × 14'
5.0 "	— apitong, 2" × 4" × 14'
2.0 "	— apitong, 2" × 4" × 16'
4.0 "	— apitong, 2" × 4" × 10'
32.0 "	— apitong, 1" × 6" × 12'

Miscellaneous materials

3.0 pieces	— soil pipe, 4" × 5'
2.0 kgm.	— common wire nails 4"
3.0 "	— common wire nails 3"
3.0 "	— common wire nails 2"

^a G. I. = galvanized iron.

FILLING THE SILO

After the silo is built, the next step is to fill it. This process is important. There are several steps in the process.

Crop to use. In the United States, silage is made from either corn, the sorghum species, or legumes. The corn and sorghum are cut into pieces, but the legumes are not cut into pieces.

It is not common in the Philippines to grow sorghum on a large scale and it is seldom used for animal feed. The probable reason for its not being used is that the stalk is coarse and fibrous and the Filipino farmers do not realize that the grain is a good animal feed.

Although a legume has a high feeding value, it is not economical to put in the silo as it is less productive than either corn or sorghum. At present in the Philippines the best crop to use in the silo is corn.

The corn for silage should be cut when it contains the maximum food nutrients. This will be when the ears are too mature for roasting and boiling, or when the leaves at the bottom of the stalk begin to turn yellow. At this stage the stalk is still sappy, so when well packed in the silo it will make good silage. If corn is put in the silo when still green the silage will be too acidic because the stalk contains a considerable amount of sugar. Also, at this stage it does not have the maximum food nutrients.

When to fill the silo. As corn can be grown in the Philippines throughout the year the silo can be filled at almost any time. However, as corn grows best during the rainy season, it seems advisable to grow corn for silage in this season.

Under Los Baños conditions corn for silage planted in the early part of August will be ready for the silo in November. At this time the work of cutting, hauling and filling the silo may be done conveniently.

Preparing the silo. One day previous to the filling of the silo the blower-cutter should be mounted, as shown in figure 16. The parts of the cutter and engine should be properly adjusted, well oiled and greased. The working condition of the outfit should be tested by cutting two or three bundles of corn. This testing is important to prevent delay when cutting is in progress.

To prevent choking of the drain pipe, the drain hole of the silo should be provided with a trap made of one-half inch smooth iron rod. Also, to reduce the spoiled silage in this part of the silo, a thick layer of cogon or straw should be put in at the bottom of the silo after provision is made for the drainage pipe.

A silage cutter. An ensilage cutter and blower is a special type of machine used in cutting and blowing forage into the silo. It is provided with four knives and fans enclosed in a steel case. As soon as the corn is cut it is blown into the silo through the pipe that connects the cutter and the silo.

It requires an engine of from six horse power and up to run a 16-inch cutter. An ensilage cutter and blower of this size costs approximately ₱600.

A farmer having a tractor can use it for power. A six-horse-power engine is about the smallest that can supply the necessary

power to run a 16-inch cutter. With this engine, occasional trouble arises, chiefly owing to the choking of the blower-pipe which results in the stopping of the engine.

Cutting the corn. While the blower-cutter and the engine are being mounted, cutting the corn in the field should be begun. The corn fodder should be hauled from the field as soon as it is cut and piled close to the silo, ready for cutting up the next day. A supply of fodder should be kept in this pile so that the cutter can be operated continuously.

Process of filling. As soon as sufficient corn fodder is ready close to the cutter, filling begins. The cutter is allowed to go at high speed before fodder is fed into it. One man feeds the cutter while a second man delivers the fodder to the cutter. The man operating the engine and cutter can also help in feeding. The fodder should be cut in short lengths ranging from one-half to three-fourths of one inch.

As silage becomes easily spoiled during hot weather, thorough packing is an important factor in the preservation of the silage. Two men do the packing. One man holds the distributor and the silage is evenly spread while trampling is going on. When the silo is about one-half full, special attention should be given to the thorough trampling of the material close to the wall.

After the silo is filled the silage settles down gradually for a few days. The amount of settling depends largely upon how well it was packed and trampled.

If it is desired to have the amount of silage up to the maximum capacity of the silo, more fodder should be added after the silage has settled down. In the College this was once done 55 days after filling. A few inches of fodder was removed from the top and then more was added until the silo was full.

Sealing the silo. The loss of silage on the top from spoilage is inevitable as it is in contact with the air. To reduce this loss to the minimum, the surface should be covered. The loss can be lessened by spreading cut straw on the surface and trampling it down, and then sowing rice on it. When the rice germinates it forms a good sealing material. In opening the silo this sealing layer should first be removed and the top layer of silage which is spoiled should be discarded. The spoiled silage may run from 12 to 24 inches thick, depending on the effectiveness of the sealing.

Distribution of labor. Filling the silo is continuous and strenuous work. It is best to finish the job at one stretch. If this is

not possible the filling may be done on successive days. The following table shows an approximate distribution of the work:

NUMBER OF MEN	ASSIGNMENT
2	Harvesters
3	Bull cart drivers
2	Helpers in loading
1	Helper in unloading
1	Operator of engine and cutter
2	Feeders
2	Tramplers inside the silo

Gas in a silo. Gas forms as a result of the fermentation of the silage. It is quite noticeable within a few days after the silo is filled. This gas is dangerous for one to breathe. Inasmuch as this gas is heavier than air, if there is not a good circulation of air, it stays on the surface of the silage for a long time. To find out whether gas is present or not a lighted lantern should be lowered to the surface of the silage. If the light is extinguished gas is present. Air circulation should be created before allowing a person to go down into the silo.

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COMPARATIVE DIGESTIBILITY IN VITRO OF PHILIPPINE BANANAS ¹

ELENA M. CAGUICLA

WITH ONE TEXT FIGURE

INTRODUCTION

The value of bananas in the diet, especially of children, is now widely acknowledged by dietitians. Pease and Rose (1917) recommended bananas as a component of the food in the diet of children. They reported that Haas used bananas in the treatment of celiac disease in children.

Ripe banana is rich in vitamin C, an excellent source of vitamin A, and not lacking in vitamin B. As a source of vitamin C, it compares well with oranges and tomatoes (Anonymous, 1927). Jansen and Donath (1924) reported that *Pisang ambon* and *Pisang radja* (two varieties of bananas in Java) were very suitable for healing xerophthalmia in connection with their experiments with rats. They said that if man is as sensitive as the rat, the daily use of from one-half to one banana would be sufficient to protect him from xerophthalmia, with the rest of the dietary consisting mainly of rice.

In the Philippines many varieties of bananas are available throughout the year. Most of these varieties can be eaten raw. When fully ripe they are very palatable and delicious.

Prescott (1918) pointed out that ripe bananas are easily digested. According to him they are more readily digestible than apples, oranges, turnips, boiled potatoes or cabbage.

In the Philippines, it is usual to give bananas to children. Parents select with care the varieties given because there is a belief that certain varieties are less digestible than others. It is then important to know whether some varieties are really more digestible than the others. There is no work reported on the digestibility of the different varieties of bananas in the Philippines.

¹ Thesis presented for graduation, 1931, with the degree of Bachelor of Agriculture from the College of Agriculture, No. 331; Experiment Station contribution No. 836. Prepared in the Department of Agricultural Chemistry under the direction of Dr. Francisco O. Santos.

The work reported in this paper was carried out in the Biochemical Laboratory of the College of Agriculture, University of the Philippines, Los Baños, from April, 1931 to October, 1931.

The aim of the work was to compare the digestibility in vitro of four common varieties of bananas.

MATERIALS AND METHODS

Philippine bananas

The bananas used were all fully ripe and were obtained from the stores in the vicinity of Los Baños. The varieties used were:

(a) Latundan, *Musa sapientum* var. *cinerea* (Blanco) Teodoro; (b) Lacatan, *Musa sapientum* var. *lakatan* (Blanco) Teodoro; (c) Saba, *Musa sapientum* var. *compressa* (Blanco) Teodoro; (d) Buñgulan, *Musa sapientum* var. *suaveolens* (Blanco) Teodoro.

The chemical analyses of these four varieties had been studied. Nuestro (1930) reported the analyses for protein and starch as follows:

For Latundan, the protein is 1.13 per cent, starch, 8.99 per cent. For Lacatan, protein is 1.19 per cent, starch, 8.32 per cent. For Saba, protein is .75 per cent, starch, 16.74 per cent. For Buñgulan, protein is 1.98 per cent, starch, 6.53 per cent.

Enzymes

The enzymes used, with the exception of salivary amylase, were obtained from Botica Boie, one of the drug stores in Manila. The trade mark is BB. They were all in powdered form and were made into solutions before using them in the present experiment. Saliva was collected from different persons, filtered, preserved with chloroform and put in the ice box.

The enzymes used were: (a) Salivary amylase, (b) pepsin, (c) trypsin (pancreatin), and (d) diastase.

The method followed was similar to that described by Carman, Smith, Havens, and Murlin (1929) in connection with their experiment on digestibility of cereals.

The two following methods were also tried, but were found inconvenient.

(a) Mouth insalivation and successive digestions on the same sample.

(b) Saliva collected and added in equal amounts to samples and successive digestion on the same sample.

In these two methods there were so many samples to work on that they could not be finished within a day and if left until the

next day they fermented. In the first method, there would be digestion before all the samples were weighed. Besides this difficulty, weighing the samples by difference into equal portions could not be done accurately. In the second method, the addition of the enzyme was not simultaneous so that before it was finished, there must have been digestion in the samples where the enzymes were added first. In all cases, the digestions were stopped by heating the samples. Salivary amylase is not wholly inactivated by heating to boiling temperature (Carman, Smith, Havens, and Murlin, 1929).

So the method of separate digestion of the samples by different enzymes was adopted.

Salivary digestion. Three-gram samples of well mashed bananas were weighed into beakers and then 80 cc. of water were added to each. Ten cubic centimeters of saliva were measured into test tubes and then added simultaneously to all the samples by means of a tilting device which is shown in figure 1. To prevent

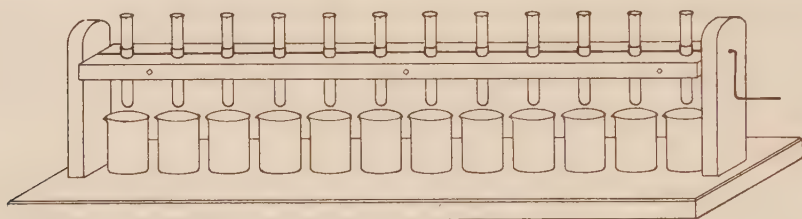


Fig. 1.—Showing the tilting device.

digestion, twenty-five cubic centimeters of 15 per cent sodium tungstate were added immediately to the controls after the addition of the enzyme. The rest of the beakers were placed in a water bath heated to temperatures of from 38°–39°C. Twenty-five cubic centimeters of 15 per cent sodium tungstate were added at the expiration of each digestion.

The samples were filtered and sugar was determined from the filtrates using the Benedict's quantitative method as described by Hawks (1921).

Peptic digestion. Five-gram samples of well mashed bananas were weighed into beakers and 80 cc. of water were added to each. Then 20 cc. of one-tenth normal hydrochloric acid were added to each sample. Eight cubic centimeters of 2 per cent pepsin solution were measured into test tubes and then added simultaneously to the samples. Twenty-five cubic centimeters of 15 per cent sodium tungstate were added immediately to the controls. The rest of the

beakers were placed in water bath heated from 39° to 40° C. Digestion was stopped at proper lengths of time by the addition of 20 cc. of 15 per cent sodium tungstate solution. The samples were filtered and nitrogen determinations were made on the filtrates by the Kjeldahl method.

Tryptic digestion. The same general method was followed for studying the effect of trypsin as for studying the effect of pepsin. Five-gram samples of mashed bananas were weighed into beakers and then 80 cc. of water were added to each. Twenty-four hundredths gram of sodium carbonate was added to each. Then 8 cc. of a 3 per cent trypsin solution were poured simultaneously from test tubes into all the beakers. (See fig. 1.) Digestion then continued for the requisite lengths of time at 39°–40°C., at the expiration of which, digestion was stopped by the addition of sodium tungstate. Filtration and determination of the nitrogen in the filtrates then followed.

Diastatic digestion. Five-gram samples of mashed bananas were weighed into beakers and then each was diluted with 80 cc. of water. Ten cubic centimeters of a 3 per cent solution of diastase were dumped simultaneously into the samples and addition of sodium tungstate solution to the controls followed immediately.

The rest of the samples were placed in a water bath heated from 39° to 40°C. and digestion proceeded for a proper length of time, at the expiration of which, 25 cc. of 15 per cent solution of sodium tungstate were added. The samples were then filtered and sugar was determined on the filtrates by Benedict's quantitative method.

RESULTS

The results which are all averages of twelve replications are given in table 1.

Table 2 shows significances of differences in percentage of digestion.

1. With saliva, the varieties of bananas studied can be arranged according to their digestibility as follows: Saba, first; Latundan, second; Buñgulan, third; and Lacatan, fourth.

2. With pepsin they can be arranged as follows: Latundan, first; Saba, second; Lacatan, third; and Buñgulan, fourth.

3. With trypsin, they can be arranged as follows: Latundan, first; Saba, second; Buñgulan, third; and Lacatan, fourth.

4. With diastase, they can be arranged as follows: Latundan, first; Buñgulan, second; Lacatan, third; and Saba, fourth.

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TABLE 1
The percentage of starch digested to sugar by ptylin

	15-MINUTES	1-HOUR	2-HOURS	3-HOURS	4-HOURS
Latundan	6.47±.183	15.96±.030	24.20±.010	36.10±.021	36.92±.013
Lacatan	5.58±.038	10.05±.020	11.08±.010	11.41±.004	11.73±.010
Saba	13.71±.050	25.03±.036	33.01±.036	35.75±.054	38.58±.042
Buñgulan	6.04±.180	15.61±.013	17.04±.013	17.27±.020	18.17±.027

The percentage of protein digested by pepsin

Latundan	17.10±.063	22.46±.063	28.76±.101	37.38±.068	37.97±.078
Lacatan	15.69±.060	18.21±.054	21.76±.033	25.97±.099	26.46±.089
Saba	17.17±.034	22.96±.078	25.90±.087	28.13±.093	29.17±.076
Buñgulan	8.61±.042	12.62±.029	18.52±.046	23.90±.029	24.35±.037

The percentage of protein digested by trypsin^a

Latundan	15.50±.074	25.34±.073	34.49±.040	35.00±.041	35.00±.041
Lacatan	15.41±.052	20.24±.055	20.36±.067	22.74±.090	22.74±.090
Saba	14.89±.133	21.97±.101	24.78±.088	26.43±.072	26.43±.072
Buñgulan	11.79±.022	18.71±.084	24.99±.035	24.99±.035	24.99±.035

The percentage of starch digested to sugar by diastase

Latundan	18.34±.010	43.55±.093	58.75±.059	61.04±.060	62.29±.084
Lacatan	13.09±.019	23.55±.015	28.39±.039	49.36±.058	53.61±.050
Saba	9.08±.038	19.82±.045	28.71±.031	29.08±.046	30.45±.041
Buñgulan	17.97±.031	32.85±.052	54.98±.015	63.78±.027	64.79±.025

^a Pancreatin was used for tryptic digestion.

TABLE 2
Showing significance of differences in average percentage
of starch digested to sugar by ptylin

DURATION	15-MINUTES			1-HOUR			2-HOURS			3-HOURS			4-HOURS		
	Differ- ence	Prob. error of dif- ference		Differ- ence	Prob. error of dif- ference		Differ- ence	Prob. error of dif- ference		Differ- ence	Prob. error of dif- ference		Differ- ence	Prob. error of dif- ference	
Latundan vs. Lacatan	0.87	0.180	S	5.91	0.036	VS	13.12	0.014	VS	24.69	0.022	VS	25.19	0.016	VS
Latundan vs. Saba	7.20-	0.190	VS	10.07-	0.047	VS	8.81-	0.037	VS	0.35-	0.058	VS	1.66-	0.044	VS
Latundan vs. Buñgulan	0.40	0.250	I	0.35	0.033	S	7.16	0.016	VS	18.83	0.037	VS	25.75	0.030	VS

Showing significance of differences in average percentage
of protein digested by pepsin

DURATION	15-MINUTES		1-HOUR		2-HOURS		3-HOURS		4-HOURS						
	Differ- ence	Prob. error of dif- ference	Differ- ence	Prob. error of dif- ference	Differ- ence	Prob. error of dif- ference	Differ- ence	Prob. error of dif- ference	Differ- ence	Prob. error of dif- ference					
Latundan vs. Lacatan	1.41	0.087	S	4.25	0.083	VS	7.00	0.110	VS	11.41	0.120	VS	11.51	0.120	VS
Latundan vs. Saba	0.07	0.072	I	0.50	0.100	S	2.86	0.133	VS	9.25	0.120	VS	3.80	0.110	VS
Latundan vs. Bungulan	8.49	0.076	VS	9.84	0.069	VS	10.24	0.011	VS	13.48	0.078	VS	13.62	0.086	VS

S- Significant

VS- Very significant

I-Insigificant

*Showing significance of differences in average percentage
of protein digested by trypsin*

DURATION	15-MINUTES			1-HOUR			2-HOURS			3-HOURS			4-HOURS		
	Difference	Prob. error of difference		Difference	Prob. error of difference		Difference	Prob. error of difference		Difference	Prob. error of difference		Difference	Prob. error of difference	
Latundan vs. Lacatan	0.09	0.090	I	5.10	0.091	VS	14.13	0.078	VS	13.26	0.099	VS	13.26	0.099	VS
Latundan vs. Saba	0.61	0.150	S	3.37	0.124	VS	9.71	0.097	VS	12.26	0.083	VS			
Latundan vs. Buñgulan	3.71	0.077	VS	6.63	0.111	VS	9.50	0.053	VS	11.01	0.054	VS			

*Showing significance of differences in average percentage
of starch digested to sugar by diastase*

DURATION	15-MINUTES			1-HOUR			2-HOURS			3-HOURS			4-HOURS		
	Difference	Prob. error of difference		Difference	Prob. error of difference		Difference	Prob. error of difference		Difference	Prob. error of difference		Difference	Prob. error of difference	
Latundan vs. Lacatan	5.25	0.021	VS	20.00	0.096	VS	30.36	0.056	VS	11.68	0.084	VS	8.68	0.098	VS
Latundan vs. Saba	9.26	0.039	VS	24.73	0.121	VS	30.04	0.050	VS	31.96	0.076	VS	31.84	0.094	VS
Latundan vs. Buñgulan	0.37	0.033	S	10.70	0.110	VS	3.80	0.042	VS	2.74	0.066	VS	2.50	0.088	VS

S—Significant
VS—Very significant
I—Insignificant

ABSTRACT ¹

A comparative test of some promising College seedlings and two commercial varieties of sugar cane in the College of Agriculture. TROADIO T. LEGASPI. (*Thesis presented for graduation, 1931, from the College of Agriculture No. 332; Experiment Station contribution No. 837.*)—The objects of this work were: (a) To find which of the College seedlings so far selected and now in the College collection are commercially promising in the College of Agriculture; and (b) to compare some important agronomic characters of these selected College seedlings with M-1900 and Luzon White.

This work was carried on from January, 1930 to February, 1931 in an old citrus orchard field located in the Experiment Station ground, College of Agriculture. The land had been planted to corn the previous season. The ground was plowed and harrowed twice.

In this study the author used twenty-four P.B.² seedling canes; namely, P.B.176, P.B.277, P.B.280, P.B.283, P.B.284, P.B.292, P.B.295, P.B.297, P.B.312, P.B.329, P.B.331, P.B.335, P.B.340, P.B.344, P.B.349, P.B.363, P.B.366, P.B.367, P.B.389, P.B.395, P.B.403, P.B.407, P.B.408, and P.B. Unknown; and two commercial cane varieties; namely, M-1900 and Luzon White.

All cuttings, each having three nodes, were soaked in running water for thirty-six hours after which they were planted one to a hill about 50 centimeters apart in each row and one meter between rows. Each P.B. row was alternated with a row of M-1900 or of Luzon White. There was no replanting to fill up the vacant hills. The whole field was irrigated once; weeded twice; off-barred when about two months old and hilled-up a month later. The percentage of germination, tillering habits, tonnage, actual yield, juice analysis, height, and susceptibility to major diseases of each variety were observed.

M-1900 had 70.67 per cent germination and Luzon White had 78.00 per cent. Fourteen P.B. canes proved to be better germinators than either M-1900 or Luzon White. Four P.B. canes had a very high percentage of germination; P.B.366 had 92.2 per cent germination, P.B.329 had 90.82 per cent, P.B.283 had 91.86 per cent, and P.B.335 had 90.91 per cent.

¹ Abstract prepared as part of required theme work in English 3a, College of Agriculture.

² These canes were produced in the Plant Breeding Division of the College of Agriculture, hence the name P.B. from Plant Breeding.

M-1900 had an average weight per stool of 5.53 kgm. and Luzon White had 3.52 kgm. Only two P.B. canes were found to have a heavier yield per stool than either M-1900 or Luzon White. These were P.B.277 which had an average weight of 6.09 kgm. and P.B.349 which had 6.66 kgm. From the average weight per stool for each variety the tons of cane per hectare were computed. M-1900 gave 60.64 tons to the hectare and Luzon White, 50.51 tons. Eleven P.B. canes gave higher tonnage per hectare than either M-1900 or Luzon White. P.B.349 gave the highest yield, 91.37 tons to the hectare, P.B.395 gave the second highest yield, 89.2 tons to the hectare.

The number of piculs of sugar per hectare for each variety was computed from the result of analyzing samples of cane juice. The analysis was made by the U.P. Sugar Mill. M-1900 gave a yield of 140.06 piculs of sugar to the hectare and Luzon White gave 93.92 piculs. Only two P.B. canes were found to give more piculs of sugar to the hectare than M-1900. These were P.B.349 which gave 157.02 piculs and P.B.395 which gave 146.66 piculs. A majority of the P.B. canes gave more piculs of sugar per hectare than Luzon White. None of the P.B. canes had a higher quality of ration than M-1900. For the purpose of determining the time of maturity for each variety two juice analyses were made, one when the plants were 10 months old and the other when the plants were 11 months old. According to these analyses a majority of the P.B. canes and the M-1900 and Luzon White had higher polarization and apparent purity at the age of 11 months than at the age of 10 months.

M-1900 had an average height of 177.12 cm. and Luzon White, of 173.12 cm. In general, the P.B. canes were taller than either M-1900 or Luzon White. All P.B. canes, except P.B.408, flowered, while M-1900 and Luzon White did not. Of all the varieties studied, only P.B.295, P.B.292, P.B.335, P.B.280, P.B.297, and P.B.389 were not attacked by Fiji disease. The degree of infection of the rest of the varieties ranged from 10.53 to 67.48 per cent. None of the varieties, except P.B.283 and P.B. Unknown, were attacked by smut. Only M-1900 was attacked by leaf scald. All P.B. canes were free from mosaic; M-1900 and Luzon White were infected to a certain extent.

Therefore, taking all agronomic characters into consideration, P.B.395 and P.B.349 may be considered better than either M-1900 or Luzon White; though P.B.395 was more susceptible to Fiji disease and P. B.349 had a lower percentage of germination than either of the commercial canes.

—Abstract by Magno T. Tenebro.

CURRENT NOTES

The proper packing of the material in the silo is most important. If not properly packed or sufficiently tramped to exclude air, spoiled silage results. It is a well-known fact that the more the material is tramped during filling the less it settles afterwards.

When the material settles in the silo, it tends to draw away from the walls, leaving an air space, which results in spoiled silage. The best method is to build the material up about 2 feet around the walls and sloping to centre, and to trample this down well; then fill the centre up and tramp it around the walls equally, then again build up around the walls, and so on. By this means silage is rounded off by being made higher in the centre, and within a few days it will settle till nearly level.

Trampling is more important in the upper half and top of the silo, because this silage has less weight bearing on it to force it down.

—*Queensland Agricultural Journal*, May, 1932.

On a minimum calculation one million deaths from malaria occur in India every year which implies a hundred million cases of sickness from the same cause.

More than half of Ceylon has been decimated by malaria. The extensive ruins of the buried cities and the great irrigation system of tanks show that it once held a dense and prosperous population. Today that half of Ceylon has a population of only about 40 per sq. mile of malaria-stricken people. The other half of the island has a population of nearly 400 per sq. mile.—*Straits Times*.

—*Reprinted in The Planter*, F.M.S. June, 1932.

Linen towels of about 2000 B.C. discovered at Thebes by the Egyptian Expedition of the Metropolitan Museum of Art are said to be constructed with knots and to be extraordinarily like our modern bath towels. Photographs of them are reproduced in Section II of the Museum's Bulletin for March.

—*Journal of Home Economics*, June, 1932.

Weekly village fairs, which have proved successful in several parts of the Federated Malay States, have recently been organized at ten convenient centres in Kedah by a Committee of which the Assistant Principal Agricultural Officer is Chairman. Fairs at two

other centres are being arranged. Their object is to provide opportunities for the Malays to sell at reasonable prices, or to barter, their rice, vegetables, meat, fish, poultry, tobacco or other produce and thus to encourage and extend the planting of foodstuffs and fruit and the rearing of animals and poultry. A similar fair has recently been started in Kampong Bahru, Kuala Lumpur. These fairs can materially assist in adjusting supply and demand in different parts of the country.

—*The Malayan Agricultural Journal*, June, 1932.

After accidentally stepping on a cherry stone and observing the greasy spot left on the floor, an orchardist and canner now uses the pits as well as the fruit. The oil in the kernels is pressed out and used in the making of cosmetics, the left-over cake in the press is sold for fertilizer, and the shells are utilized for fuel.

—*Popular Mechanics*, April, 1932.

The twenty-first Egg-laying Competition for fowls, and the fourth for ducks, which began on April 1st 1931, concluded on March 1st, 1932, a period of 48 weeks. For the first time for many years the entries received were insufficient to fill the pens, only 528 fowls and 36 ducks being entered. This comparatively small entry probably was due to the fact that the entry fees had been increased, and some former competitors doubtless could not see their way clear to pay the higher fee.

For the 1932-33 Competition the Department has reduced the fees payable and it is gratifying to note that the number of entries received was very much in excess of the number of pens available. It was necessary that the pens should be balloted for and, unfortunately, some of the regular supporters of the competition were unsuccessful. It is hoped, however, that this will not deter them from entering birds again next year.

—*Journal of Agriculture*, Victoria, May, 1932.

If you were served at a single meal all the average person eats in a lifetime, you would sit down to a beefsteak weighing as much as six dressed steers, confront a giant potato too big for a two-ton truck to haul, cut slices from a loaf of bread higher than your head, and pour milk from a bottle as tall as a bungalow!

In the fifty-six years that the average American lives, recent statistics compiled by the U.S. Department of Commerce show, he consumes 106,400 pounds of food—enough to load to capacity several freight cars.

On other dishes at this colossal feast there would be a half-ton block of butter and a 224-pound slice of cheese. The sugar bowl would be six feet high and the salt shaker would weigh 800 pounds. There would be an egg 12,000 times the average size, an apple seven feet in diameter, an orange weighing 1,100 pounds. Around your table would be piled 1,120 tins of canned fruit, 124 cans of salmon, 600 tins of sardines, 336 pounds of dried fruit, 888 cartons of breakfast food, and, more surprising still, 280 pounds of rice. To top off your meal, you would find a 672-pound box of candy and nearly 6,000 sticks of chewing gum, not to mention fifty-six pounds of walnuts and 1,176 pounds of grapes.

—*Popular Science Monthly*, July, 1932.

COLLEGE AND ALUMNI NOTES

Governor General Theodore Roosevelt accompanied by the American Trade Commissioner, Mr. E. D. Hester, formerly Professor of Rural Economics in this College, and Hon. Rafael Alunan, the Secretary of Agriculture and Natural Resources, paid a visit to the College of Agriculture on Sunday, July 10, 1932. The Governor's party which arrived about 9:00 a. m. was taken through different laboratories and shown around the Campus by Dean Gonzalez. A Manila appointment made it necessary that the party leave at about 11:30 a. m.

Mr. and Mrs. Frazier Hunt and son and Mr. Philip Kingsley were visitors on the College Campus on August 6. Mr. Hunt is a well known war correspondent and traveller. He was very much interested in the work of the College, particularly that of the Department of Animal Husbandry as he owns a ranch in Alberta, Canada. Mr. Kingsley is connected with the *Chicago Tribune*. They were accompanied by Assistant Director Buencamino of the Bureau of Animal Industry. In the absence of the Dean, Doctor Fronda acted as guide and host. After a luncheon given at the Molawin Hall the party returned to Manila.

Professor A. Nakanome, President of the College of Foreign Languages in Osaka, Japan was a Campus visitor on August 7. He was accompanied by four of his graduates now employed with commercial firms in Manila.

On July 23, Dr. E. B. Copeland was the Convocation speaker. Naturally, as Founder and First Dean of the College, he told of the pioneer days of the College, more especially of the first three years. It was of much interest as well as of value for the present students to learn of the lives of students in those early days, not that the Founder put any wail or whine into his story. Quite the contrary. One felt that those were in truth the "good old days"—the thrilling heroic days.

The Society for the Advancement of Research, (S.A.R.) an honorary and scientific organization, gave its first public program for the academic year 1932-1933 on the evening of August 4 in the College Auditorium. A dinner at Molawin Hall for the members and special guests of the Society preceded the program.

In his opening remarks the President of the SAR, Dr. L. B. Uichanco, delved into the value of the experiences of our predecessors, and the systematic arrangement of data for scientific work, and the importance of properly giving due credit for the work of our contemporaries. After his remarks, the new associate members were initiated. These were: Messrs. Rafael B. Rotor, Dominador D. Clemente, Salvador B. Oliveros, Nazario A. Pidlaoan, and Rufino B. Gapuz.

Dr. N. B. Mendiola, the first president of the SAR, introduced the Guest of Honor, Dr. Edwin Bingham Copeland. He introduced him not as Founder and first Dean of the College of Agriculture, but as an ardent botanist, a conscientious scientist, and a faithful research man. Doctor Copeland told of his happy experiences, in his studies of the ferns, and how these plants had occupied his spare time for more than twenty years. In this lecture Doctor Copeland demonstrated by means of slides, and numerous drawings and photographs projected on the screen, the outstanding features and characters so essential to the systematics of one of the genera (*Trichomanes*) of the filmy ferns. The study of ferns, according to Doctor Copeland is not at all hard; in fact any one can do it if given the chance. In the course of his lecture he made mention and showed a drawing of a species of *Trichomanes*, *T. beccarianum* from Mount

Maquiling. This species was collected for the first time only in the last week of July, 1932. This fern is so minute, so inconspicuous that it is not a matter of surprise that it has been overlooked so long. Doctor Copeland's lecture was most interesting from the point of view of a systematist, and he made it more so by the way he presented his material.

Evidence relating to the transmissibility of the Fiji disease of sugar cane (*Saccharum officinarum* L.) by an insect vector was obtained by Dr. G. O. Ocfemia of the Department of Plant Pathology, in August, 1932. Doctor Ocfemia conducted his experiments in especially constructed insect-proof chambers using POJ 2878 sugar cane as material and adults of the leaf-hopper, *Perkinsiella vastatrix* Breddin, Delphacidae as vector. Further insect-transmission experiments are in progress at the College of Agriculture. A more detailed report of the experiments will be published elsewhere.

The seventy-fourth meeting of the Los Baños Biological Club was held July 28, 1932, at 7:30 p. m. in the Poultry Husbandry lecture room of the College of Agriculture.

The following papers were read and discussed:

1. "To what extent can actual head measurements of Cantonese hens be used in selection?" By Dr. F. M. Fronda and Acelo C. Badelles. (Read by Dr. F. M. Fronda.)
 2. "On the performance of a tractor engine using gasanol, gastarla, and mixtures of pure kerosene and crude oil as fuels." By Dr. A. L. Teodoro and J. Banzon. (Read by Dr. A. L. Teodoro.)
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The Center, the new recreation hall opened on the evening of July 23 a series of educational and recreational evenings to be given every two weeks. On this evening Dr. Rebecca Parish Superintendent of the Mary Johnston Hospital, Manila, spoke on "What is Patriotism", and Mrs. J. F. Boomer, of Manila sang two delightful groups of songs with the charm and rich, sweet voice that makes her so much in demand. Doctor Parish treated her subject as she treats all subjects—simply, practically and earnestly—with no blah.

On the evening of August 6, Assistant Professor Anne Cole of the Department of English was the speaker. She took her audience with the help of Mr. Bousman and his projecting machine on a pleasant and most instructing trip to Siam. Four realistic scenes presented under Miss Cole's direction by Siamese students in Siamese dress gave a realistic touch to the trip.

In *The Cornell Countryman* of May, 1932 appeared an article, "A Visit to the Philippines" by Esther Warren '29 and Stanley Warren '27. Doctor and Mrs. Warren were Campus residents for about a month last February and March. This article gave a most flattering description of our Campus and pays warm tribute to the hospitality of the faculty. In telling of the Cornell students on the Campus the article says, "Cornell can be justly proud of the fine work which the Cornellians are doing."

In the issue of *Philippines Free Press* under date July 23, was a full digest of the article "Romance of Quinine" which appeared in the July PHILIPPINE AGRICULTURIST.

On July 1, Tarzan the recently purchased grade Arabian stallion arrived at his new home, the College Campus. The mother of Tarzan is a daughter of Hassan, for some years the College stallion. His father is Dick, a pure bred Arabian stallion on Alabang Stock Farm. Hence, Tarzan is three-fourths Arabian. He was bought from Mr. Carlos Sandico, of Mexico, Pampanga. Tarzan is five years, five months old, fifty-six inches high, and gray in color.

On July, 1932, one pure bred Holstein bull, two grade Hereford bulls and two Indian buffalo bulls were acquired by the Bureau of Prisons from the Department of Animal Husbandry. These bulls will be used at the Iwahig Penal Colony in line with the program to improve its live stock recommended by Dean Gonzalez at the time of his visit to the Colony last summer.

On July 26, 1932, five Mule-Foot pigs were received by the Department of Animal Husbandry from the Bureau of Prisons. These animals are of good conformation and quality. It is claimed that they are hardy. They are now under observation in the department to determine more fully their merits.

Among the text books recently adopted by the Philippine text book board was *New Civic Biology* by G. W. Hunter and Leopoldo B. Uichanco. Also *Laboratory Manual in Civic Biology* by Leopoldo B. Uichanco.

Doctor Uichanco is further distinguished by a poem from his pen "Rice Planter" which first appeared in the *Philippine Magazine* being selected for the revised edition of *Philippine Prose and Poetry*, Book One.

An article by Professor Emma S. Yule "A Royal Cremation in Siam" which appeared in October, 1930 issue of *Inter-Ocean* (Batavia, Java) was chosen for a selection in Book One, *Philippine High School Reader* by Mendez, Mendez and Potts.

Santiago Festin, '18 purchased from the College on July 19, 1932 an Indian Nellore bull for his cattle ranch at Pato, Tablas Island, Romblon. The bull will be used to head a herd of selected Philippine native cows as Mr. Festin is very desirous of introducing the Nellore blood in his herd, hoping to produce crossbred animals.

A letter to the Dean from Mr. Roem Purnariksha B.S.Agr. '28 tells that Mr. Charoon Suebsaeng B.S. Agr. '28 was one of the 110 Civilian Employees of the government who joined the Army and Navy of Siam in demanding from the King constitutional government. "Charoon has a seat among the seventy" writes Mr. Purnariksha. Roem's letter head address is "Faculty of Arts and Science, Chemistry Department," but in his enthusiasm for the great changes in his country's government and Suebsaeng's part, he omitted information about his own work.

Mr. Thongdee Resananda '24 is now at the Kuan Miang Experiment Station, Siam. He writes Doctor Mendiola that he intends to be a life subscriber for THE PHILIPPINE AGRICULTURIST.

Mr. Eulalio Baltazar, B.S.Agr. '24 instructor in agronomy, now carrying graduate work in University of Texas reports that the degree of Master of Science with major in fibers and textiles has just been conferred upon him.

Mr. Dionisio Pastorfide '17 enrolled recently in the College as a Special student. He will devote himself to the study of soap-making. He will apply this knowledge to the converting of his coconuts into soap. Object: greater profit.

Francisco F. Octubre, '15, is acting superintendent of Maligaya Rice Station, Muñoz, Nueva Ecija. He is engaged in the propagation of selected lowland rice varieties for future distribution to the public. He is also working on tobacco and cotton as possible crops in a system of diversification in the rice provinces of Central Luzon.

Cipriano C. Nacion, '23 in a letter to Dr. F. M. Sacay, tells of his work in Occidental Negros as industrial supervisor of schools.

Arcadio Matela, '29, a teacher in San Carlos Rural High School, writes Dr. N. B. Mendiola that he plans to introduce in his school elected for the year the following officers:

Sebastian F. Fabello '29, is on the teaching staff of Lapak Agricultural High School in Sulu.

The Associated Women Students of the Los Baños Colleges elected for the year the following officers:

Elena Caguicla	-----	President
Andrea Balbin	-----	Vice President
Maximina Mulimbayan	-----	Secretary
Pilar Elayda	-----	Treasurer

Miss Katherine Turner is Adviser by appointment.

Officers elected for the year by the Mimics are:

Pedro Lorenzo	-----	President
Onofre Casupang	-----	Vice President
Martin Rosell	-----	Secretary
Miguel de Guzman	-----	Treasurer
Domingo Regner	-----	Stage Manager
Basune Saropie	-----	Business Manager
Valeriano Revicencio	-----	Advertising Manager
Andres Caranto	-----	Property Custodian

Assistant Professor Anne Cole is Director by appointment.

AGRICULTURAL EDUCATION AMONG NEGROES IN SOUTHERN UNITED STATES: II ¹

HAMPTON NORMAL AND AGRICULTURAL INSTITUTE ²

This Institute is located in Hampton, Virginia. It is one of the oldest vocational schools for Negroes and one of the few well-known Negro educational institutions. It is nationally recognized as a pioneer in demonstrating the educational value of manual labor and in correlating academic instruction with industrial training. The school was established in 1868 at the suggestion of General Samuel Chapman Armstrong, a white officer of colored troops during the Civil War. He became its first principal.

Administration

The Institute is controlled by a board of trustees of seventeen members. The administration of the institution is mostly in the hands of white officials. The majority of faculty members are also white, especially in the college division.

The institution derives its support from interest on endowments and from gifts and contributions from interested parties. The interest on endowment funds in 1926-27 amounted to \$426,184.28. The total income of the school amounted to \$540,324.28.

The school plant covers an area of 990 acres, 916 of which are used as farms by agriculture students. The school has 139 buildings valued at about \$1,452,000. Some of the buildings were erected wholly or in part by vocational students in the trade school.

Educational program

The present educational program of the school includes primarily two levels: secondary and collegiate. In addition, elementary work

¹ General contribution from College of Agriculture No. 315. Received for publication July 28, 1932.

Much of the material reported in this section was taken from A. J. Klein. 1929. Survey of Negro colleges and universities. U. S. Bureau of Education Bulletin 7:1-964, 1928.

² For more detailed information, refer to Hampton Normal and Agricultural Institute. 1930. Sixty-second annual catalogue, 1929-30. p. 157.

is given in Whittier Training School, established primarily for practice teaching. Originally, the Institute was established principally as a technical secondary school, to give academic and vocational training to colored youths. Recent development indicates a transition from this status to that of an institution of collegiate grade.

In the year 1926-27, a total of 610 students was enrolled in academic and vocational curricula of secondary grade. Preparation for vocations in the following fields is provided: agriculture, household arts, mechanical trades, business and teaching. The trade school department offers instruction in various trades, such as automobile mechanics, blacksmithing, bricklaying, carpentry, machinery, printing, painting, plumbing, tailoring, tinsmithing, and upholstering. The vocational student spends at least 4,000 hours a year in practical work. All the repair work and part of the construction of the physical plant of the Institute are done by the students. Contracts for outside work are also accepted, such as furniture repairing, printing, tailoring, automobile painting, etc. The student thus learns and earns at the same time.

The college division enrolled 382 students in 1926-27. Of this number, 145 were men and 237, women. The college offers four-year curricula leading to a bachelor's degree in agriculture, business, trade, education, home economics, library science, or music. A two-year curriculum in education is offered, leading to a diploma. The majority of the students are in the freshman and sophomore years, the number being 264 and 84, respectively. This is due to the existence of two-year curricula. There were only 23 in the junior class and 11 in the senior class. Very few students stay for the four-year curricula. The Institute started to grant degrees only in 1923. By 1927, 29 degrees had been granted.

Self-support

Opportunities for self-support are offered by the Institute to students. The dormitories, kitchen, dining room, laundry, and repair and upkeep of grounds and buildings are under the direction of students. A certain number of first year students is allowed to work all day and attend classes for two hours at night. The following year, the student, having accumulated enough money, spends more time in completing his back work. College students are also given opportunities to earn and study at the same time. Freshmen are allowed to work from six to eight hours a day and attend classes for two hours. With his savings a student is able to devote more time to class work in the following year. Or he may

work for only four hours a day and carry half of the regular class program. In this way he earns about three-fourths of the expenses for board, room, light, and laundry. Students in the freshman as well as in the sophomore, junior, and senior years may work for two hours a day and carry full load. Thus, a student is able to earn a certain portion of his expenses for board and lodging. This policy of providing work for students enlarges the educational experiences of students. It also enables poor students to attend the school.

Community service

In addition to its resident work, the Institute carries on an extensive extension program. Its extension activities reach colored people of diverse interests. It sends out farm demonstration agents, and holds short courses for farmers. It conducts an annual conference for farmers, teachers of agriculture, county agricultural and home demonstration agents, and rural life workers. The Institute helps school teachers and rural school supervisors through summer courses and by means of leaflets on educational matters. The builders' conference brings together persons engaged in the building trades to exchange experiences and ideas. The minister's conference brings together ministers of all denominations to discuss their common problems and devise ways to make their work among country people more effective. The Institute sends speakers to conferences, meetings, fairs, and conventions of various sorts. It also issues publications of value to those interested in understanding and meeting the educational and practical needs of the community.

Hampton Institute, being a pioneer in the field of vocational education for colored youths, has made far-reaching contributions to the welfare of the race not only in America but also in Africa and other countries. Many who have gone through this institution have become teachers and leaders of the race, Booker T. Washington being an outstanding Hampton man. Others have gone into farming, trades, business, the professions, and other lines of work.

Thousands of visitors—educators, missionaries, school officials—from various sections of America and from other countries visit the school.

TUSKEGEE NORMAL AND INDUSTRIAL INSTITUTE ³

This Institute is probably the most widely known Negro institution. It is located in Tuskegee, in the heart of the "black belt" of

³ For more complete information, refer to Tuskegee Normal and Industrial Institute. 1930. The Circular of Information. 31 p. Tuskegee Institute Press.

Alabama. It was established in 1880 with the aim of providing educational opportunities for Negro youth similar to those offered by Hampton Institute. Booker T. Washington, a graduate of Hampton and generally regarded now as the foremost leader the Negro race has ever had, was engaged as its first teacher. He spent his life in building up the institution to its present standing. "The genius of Booker T. Washington gave to the institution world-wide fame as the exponent both of the educational value of manual labor and the correlation of academic subjects with industrial training."⁴ He did much to convince the Negroes and white people of the great need for voca-



Fig. 1.—Monument, Dr. Booker T. Washington, Tuskegee Institute, Alabama.

tional education. His advice to his people was to "make themselves of value to their community by fitting themselves for their best productive service in whatever form of labor they might undertake."

Administration

The Institute is a privately endowed institution. It is governed by a board of trustees composed of influential white and colored men from the North and the South. In addition to its income from the endowment and invested funds, it also receives contributions from the State of Alabama, General Education Board, and Slater Fund. The total income in 1926-27 was \$451,168.44, of which 68.2 per cent came from interest on endowment.

⁴ JONES, THOMAS JESSE. 1917. Negro education: a study of the private and higher schools for colored people in the United States. U. S. Bureau of Education Bulletin: 39:1-423. 1916.

The school plant, valued at \$2,200,000, consists of 1,850 acres of land, 1,740 of which are used as farms, and 30 buildings for administrative offices, classrooms, laboratories, dormitories for students and teachers, chapel, hospital and farm buildings.

Educational program

The school offers three levels of instruction: elementary, secondary, and collegiate. The enrollment for 1926-27 consisted of 423 elementary pupils, 1,324 high school students, and 97 college students. Probably half come from Alabama, the others from various states of the Union and a score of foreign countries. Since the beginning, the administrative officials and teachers of the school have all been colored.

The elementary school is used for practice teaching by students enrolled in the normal course. The secondary division offers academic subjects, and, in addition, vocational courses in agriculture, home economics, trades and industry. It is for its vocational program that the institution is famous. Students are given practical training which will prepare them to meet problems of practical life.

Students are classified in vocational groups depending upon the student's choice. The student spends only three days a week on academic subjects. In agriculture, for example, the student spends three days a week in field practice. Instruction is provided in the following mechanical trades: automobile mechanics, blacksmithing, brickmasonry, carpentry, electrical engineering, upholstering, harness making, machine work, painting, printing, plumbing, tailoring, tinsmithing, and wheelwrighting. The girls' industries are: basketry, dressmaking, cooking, laundering, ladies' tailoring, mattress making, millinery, nursing, and plain sewing.

Night classes are held for the "work class" students. Unable to meet the expenses of the day classes, they work during the day and study at night. Their work during the day is so directed as to be of educational value to the students. It is interesting to note that all the work done about the buildings and on the campus is done by the students.

The college division offers four-year curricula leading to a bachelor's degree in agriculture, home economics, education, business, or technical lines of work. The Institute also offers a three-year curriculum leading to a diploma in nursing; two-year curricula leading to a diploma in teacher-training, business, trade, or technical work.

Extension work

In addition to its resident activities, the Institute has also an extension program. Meetings and conferences of farmers, teachers, extension agents, preachers, and county leaders are held under the auspices of the school. Summer courses are offered to elementary and high-school teachers, teachers of vocational subjects, and principals and supervisors. Extension courses in education are also offered to teachers of the county schools. Summer short courses and farmers' institutes are held for farmers. The Negro Farmers' Conference, held annually, is attended by farmers from all over the state. The workers' conference brings together persons engaged in various activities for the improvement of the Negro race. Health



Fig. 2.—Dining Hall, Tuskegee Institute, Alabama.

campaigns and demonstrations are also carried out. The “movable school” is one of the interesting features of extension activities conducted by the school. The Institute also sends out publications that are of interest to farmers, students, teachers, graduates, and persons interested in the work of the institution.

Research work is also undertaken by the school. A department of research gathers and compiles information on the Negro and publishes a Negro Yearbook and other publications on Negro life.

Graduates of Tuskegee are found in many states of the Union, and there is a heavy demand for them. Graduates have attained success in various lines of work and the name Tuskegee has become a trademark for industry and ability. These graduates have served as leaders of the race and have done much towards its advancement.

STATE AGRICULTURAL AND MECHANICAL COLLEGE OF SOUTH
CAROLINA

This institution, located at Orangeburg, South Carolina, differs from the preceding two in several ways. It is a state institution, and its support comes from public funds, primarily state funds. As the name indicates, it is primarily of collegiate level, although its charter requires maintenance of a preparatory school.

Administration

This college was established for Negroes by the General Assembly of South Carolina in 1896. Its governing body is a board of trustees elected by the Assembly. The president, administrative staff, and members of the faculty are Negroes.

The income of the institution in 1926-27 amounted to \$188,842.37, of which 71.2 per cent was state appropriation. Fees amounted to 19.3 per cent of the income in 1926-27.

The institution has a campus of 50 acres, a farm of 91 acres, and 27 buildings. The value of the physical plant is estimated at \$750,000.

Educational program

The educational program deals primarily with secondary and collegiate levels. The enrollment in 1926-1927 was 375 in the secondary school and 305 in the college.

Students in the secondary grades are offered opportunities for training in various vocations. Some of the vocations taught are: agriculture, dairying, truck gardening, machinery, applied electricity, mechanical drawing, architecture, plumbing, masonry, plastering, painting, tinning, harness making, shoemaking, and tailoring.

The college division offers four-year curricula in agriculture, arts, science, mechanics and industries; and two-year curricula in home economics, commerce, normal teacher-training, and teacher training in agriculture. Most of the students do not go beyond the second year. Of the 305 college students in 1926-27, 127 were freshmen, 117 sophomores, 42 juniors, and 19 seniors.

Extension activities

There are certain extension activities being carried on by the institution. A traveling trade expert goes around giving advice and help on construction of houses, privies and poultry houses. Through summer courses and conferences, the college helps farmers, persons engaged in trades, school teachers and extension agents.

FRANCISCO M. SACAY
Of the Department of Agricultural Education

TRACTOR ENGINE TESTS USING GASANOL, GASTARLA, PURE KEROSENE, AND MIXTURES OF PURE KEROSENE AND CRUDE OIL AS FUELS¹

A. L. TEODORO² AND J. BANZON³

WITH THREE TEXT FIGURES AND FIVE CHARTS

INTRODUCTION

Many tests have been made on the use of mixtures of alcohol, gasoline, ether, and kerosene, as fuels for engines that were designed for gasoline or for kerosene. Gasoline-alcohol combinations in various proportions have been tried successfully without much alteration of the engine. Few experiments, or possibly none at all, have been carried out with the object of studying the effects of using mixtures of kerosene and of crude oil on the types of kerosene engines on the market at present.

In the Philippines, the attention of users of tractors and of any type of kerosene engines is at present directed to the prospects of using alcohol as fuel. Any fuel that may cheaply and efficiently be substituted for kerosene should find a ready market. The writers present in this paper the results of experiments which were conducted to find out the possibilities of using mixtures of alcohol and gasoline and of kerosene and Diesel engine fuel from the standpoints of economy, crank case oil dilution, steadiness of engine operation, formation of carbon deposit on piston and in combustion chamber, and of the amount of wear and corrosion.

Review of literature

Lucke and Woodward (1907), using alcohol fuel, made extensive tests on internal combustion engines. Their objects were to determine whether the gasoline and kerosene engines on the American market in 1906-1907 could run on alcohol, and to suggest improvements which might be desirable in the design of the engines. Six engines were used; only one was of the multi-cylinder type. Strong

¹ Experiment Station contribution No. 838. Read before the Los Baños Biological Club, July 28, 1932. Received for publication, August 6, 1932.

² Associate Professor of Agricultural Engineering, University of the Philippines.

³ Instructor in Agricultural Chemistry, University of the Philippines.

and Stone (1918) made some comparative tests using gasoline and alcohol as fuels. Four single-cylinder engines were used. Ricardo (1921-1922) made a very thorough study of the use of alcohol fuels using a variable compression engine of his own make for the tests. Teodoro (1931) carried out alcohol fuel tests using multi-cylinder tractor engines as prime movers. All these tests proved that engines originally designed for either gasoline or kerosene could, with slight modification, be run on alcohol.

No published data are available concerning the use of kerosene-Diesel fuel combinations.

Objects of the present study

The objects of the present study may be grouped as follows:

1. To determine whether or not a kerosene engine of the type now used for tractors can be run on alcohol blends and on mixtures of kerosene and Diesel fuel.
2. To determine the crank case oil dilution.
3. To measure the amount of carbon deposit in the combustion chamber after so many hours of operation.
4. To determine the possible wear on the piston rings.
5. To measure the fuel consumption at various loads.
6. To measure the lubricating oil consumption after many hours of operation.
7. To suggest means by which the engine could be run at minimum cost, maximum efficiency, and at constant steady operation.

Time and place of work

The investigation was conducted in the Agricultural Engineering Laboratory and in the Chemistry Laboratory of the College of Agriculture, University of the Philippines between April 4 and July 20, 1932.

Personnel

The engine tests were made by A. L. Teodoro assisted by Instructors S. R. Cruz, E. Bautista, and B. de las Alas, all of the Department of Agricultural Engineering. The determination of crank case oil dilution, amount of carbon deposit, amount of wear on piston rings, specific gravities of oil and fuel, and viscosities of oil, was performed by Instructor J. Banzon of the Department of Agricultural Chemistry. Assistant Professor A. B. Catambay supervised the overhauling of the engine.

Acknowledgements

The authors wish to express their thanks to the International Harvester Company of the Philippines for lending to the Department of Agricultural Engineering a new 40 h.p. McCormick-Deering Industrial Power Unit; to the Asiatic Petroleum Company for supplying two brands of kerosene, Shell-Diesel fuel, and lubricating oil; to the Standard Oil Company for supplying kerosene and Socony-Diesel fuel; to La Tondeña for supplying Gasanol; and to Central Azucarera de Tarlac for supplying Gastarla.

MATERIALS AND METHODS

*Materials**Fuels:*

Gasanol and Gastarla with the following constituents were used:

Gasanol

Rectified alcohol (189 proof)	50%	by volume
Commercial ether, from	5% to 10%	" "
Gasoline, from	40% to 45%	" "

Gastarla.

Rectified alcohol (189 proof)	60%	by volume
Gasoline	40%	" "

Three kinds of pure kerosene were tested; namely, Rizal, Cross Power, and White Rose.

Two groups of kerosene-Diesel fuel mixtures were tried having the following proportions by volume:

Asiatic Petroleum Company products

1. 75% Cross Power + 25% of Shell Diesel fuel
2. 50% " " + 50% " " " "
3. 25% " " + 75% " " " "

Standard Oil Company products

1. 75% of White Rose + 25% of Socony Diesel fuel
2. 50% " " + 50% " " " "

Two kinds of pure Diesel fuels were used; namely, Shell Diesel and Socony Diesel.

Lubricating oil:

Golden Shell was used in all of the tests.

Injected water:

Tap water coming from the College water supply system was used for water injection.

Equipment

Engine. A McCormick-Deering Power Unit Model 300 was used. Thirty hours were spent for breaking-in the engine in the laboratory. The operating features and specifications are given as follows:

Operating Features

*“Replaceable Cylinders—*The cylinders are cast separately, machined, and then fitted into the engine proper. Scored or worn cylinders can be replaced easily at a reasonable cost.

*Ball-bearing Crankshaft—*The crankshaft runs in heavy-duty ball bearings. Ball bearings are always in alignment, readily lubricated, and save power for productive work.

*Lubrication—*The lubrication is of the circulating splash type. A gear-driven oil pump assures positive lubrication. A built-in oil filter conserves the lubricating qualities of the oil.

*Air Cleaner—*The air used in the fuel mixture passes through an oil air cleaner. The air cleaner has no moving parts. It is simple in construction, durable, and efficient in operation.

*Governor—*The built-in flyball throttle governor regulates the quantity of fuel mixture to the load and keeps the engine speed practically uniform. The governor is completely enclosed, thoroughly lubricated, and factory-sealed.

*Clutch—*The power unit is equipped with a single-plate clutch with unusually large friction surfaces. It is completely enclosed in the bell housing. Special equipment can be supplied to place the control lever on the left-hand side.

*Accessibility—*These power units are unusually accessible. The hood is easily raised, and the side panel can be removed to permit access to the under pan. Handholes on the side of the crankcase are provided to enable ready inspection of connecting rod and crank-shaft bearings.”

Specifications—Model 300

Horsepower	40	Fuel—Gasoline (petrol) or kerosene (paraffin)	
Bore	4-3/4 inches	Fuel Tank—capacity	19 gallons
Stroke	6 inches	Clutch—Single plate. Completely enclosed in bell-housing.	
Revolutions per minute	1,050	Bell-housing—Meets requirements No. 1, S. A. E. specifications.	
Belt Speed (feet per minute) . . .	3,300	Auxiliary Fuel Tank—capacity . . .	1/2 gallon
Ignition—High—tension magneto with impulse starter.		Pulley—diameter	12 inches
Cooling—Closed system with radiator, fan, and impeller pump.		Pulley face	9-1/2 inches
Lubrication—Circulating-splash with gear-driven oil pump; built-in oil filter.		Weight (approximate) .	2,160 pounds

The compression ratio was measured in the laboratory and found to be approximately 4.42 to 1.

Engine testing appliances. The engine was connected to a dynamometer by means of a six inch, 6-ply-belt about 42 feet long. The power was transmitted by cross belt. The dynamometer which was of the D. P. \times 4 standard hydraulic absorption type was built by Heenan & Froude Ltd., Worcester Engineering Works, Worcester, England. It was provided with a tachometer and a continuous revolution counter directly driven by worm gearing. In line with and coupled to the dynamometer's main shaft, through a Fast self-oiling flexible coupling was another shaft carrying 12-inch pulley. This coupling was manufactured by the Bartlett Hayward Co., of Baltimore, Maryland, U. S. A. The pulley shaft was carried by two Dodge-Timken "S-I-C" self-aligning expansion pillow blocks with abrasive dust closures.

A Toledo balance Style 9.466 AP was used to measure the fuel. The balance had a maximum capacity of 25 pounds, 20 of which were recorded on two beams with sliding poises, and 5 pounds on a scale dial graduated in hundredths of a pound, over which there moved a pointer actuated by the scale mechanism. A fuel tank with a capacity of about 3-1/2 gallons was mounted on the balance platform and connected to the carburetor through a length of copper tubing with a flexible coupling of rubber tubing at each end. (See fig. 1.)

A hand-tachograph was used to determine the engine speed and to check the readings of the tachometer and of the continuous counter of the dynamometer. Two stop watches reading to 1/5 second were used for recording duration of tests and for determining the fuel consumption. Three standard mercury thermometers were used to take the temperatures of the room, cooling water, exhaust water in the dynamometer, and of the lubricating oil. A regular sling psychrometer was used to measure the relative humidity.

Chemical apparatus. Weights were determined by means of an analytical balance, of the chainomatic type with a capacity of 200 grams and sensitivity to 1.10 mgm., manufactured by Christian Becker Inc., Jersey City, N. J., U. S. A. Specific gravities were determined by a set of hydrometers of German make. Viscosities were measured by a pipette viscosimeter jacketed with water to keep the temperature constant. Dilutions were determined by the method of



Fig. 1.—Fuel measuring arrangement and tractor engine used

the American Society of Testing Materials D322-30T. The special receivers or traps for the distillate in this determination were made out of burettes calibrated to 0.1 ml, at $27\frac{1}{2}^{\circ}\text{C}$. The dimensions were

in exact accordance with the specifications in ASTM D322-30T with the exception that the length of the graduated portion was 12.5 cm. instead of 10.0 cm. as specified. This increase in length increased the accuracy of reading the graduations. Time intervals were measured by a Pastor stop watch, giving readings to fifths of a second.

Procedure of tests

Overhauling the engine. Before beginning any new fuel test, the engine was thoroughly overhauled. Carbon deposits in the cylinder head, valve-heads, valve seats, pistons, rings, and spark plugs were removed. The valves were timed carefully and new lubricating oil used.

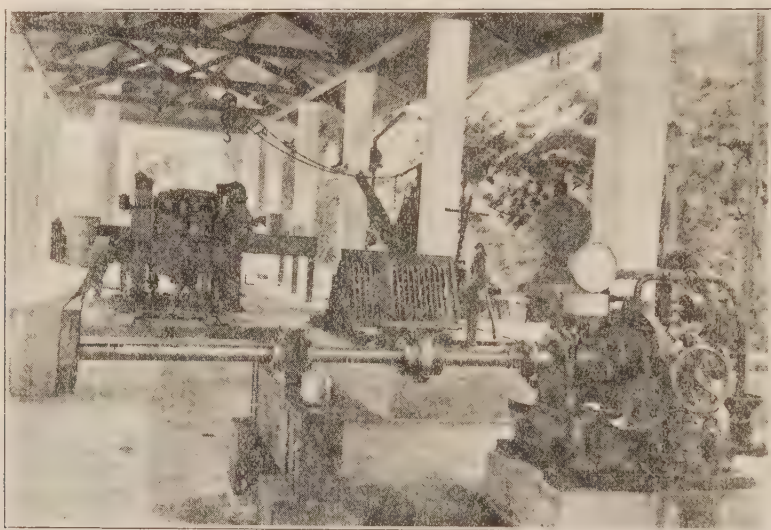


Fig. 2.—Set up of the dynamometer.

Adjustment of the engine and dynamometer. Prior to each test great care was taken to lubricate all bearings of the engine and of the dynamometer and its accessories. For a preliminary run after overhauling, the engine was started, dynamometer adjusted, clutch engaged, and the load slowly increased. Adjustments of fuel needle-valve, water needle-valve, ignition lever, and throttle lever were then made until the engine maintained a constant running condition at approximately rated speed. The engine was considered ready for any fuel test when this condition was reached.

The specific direction given by the engine manufacturer regarding the use of the manifold baffle and of the manifold control valve was followed. When operating on Gasanol and on Gastarla, attempts

were made to find the effects of different degrees of control valve openings. For pure kerosene and for mixtures of kerosene and of Diesel fuel, arrangement to utilize as much heat as could be obtained was made.

Series of tests. Two series of tests, A and B, were made for each fuel at approximately the rated speed of the engine. The first series constituted a continuous operation at or near the rated capacity for a period of ten hours. The second series was a ten-hour continuous test on fractional loads. Runs were made on three-fourths, one-half, and one-fourth loads, lasting from 100 to 120 minutes each. Varying load tests which ranged from idling to maximum capacity were carried out for about two hours.

Short tests were usually made to find the most economical carburetor setting in series A. Quarter-load tests in Series B were carried out using the optimum opening for Series A as carburetor setting. For the varying load tests, the optimum carburetor setting for the required power was found.

After more than 100 hours of continuous running, special short tests were made for each of the fuels that had been used to find whether or not any change occurred in fuel consumption, maximum power developed, and constancy of operation. The pre-heating tests on alcohol fuels were also carried out during this period with the carburetor opening set to give the optimum consumption at normal load without any pre-heating.

Whenever the term, fuel test, is used in this paper, all tests included in series A and B for one kind of fuel is meant.

Duration of test. The duration of tests included the actual time that a certain load was maintained at constant operation. The time for warming up the engine was not included.

Determination of required data. Fuel consumption: To insure a high degree of accuracy in fuel measurement, the consumption for the required power was determined at intervals of either three minutes, six minutes, or ten minutes. In general, from 40 to 50 readings, each of ten minutes duration, were made in series A. At least ten readings based on shorter intervals were made in each test in Series B. Only as much fuel as could be measured out within the range of the five-pound scale chart of the balance was used without refilling the container. Fuel was poured into the container until the scale indicator stood beyond the five-pound mark. As the pointer moved back, the time for a conveniently observed scale reading was caught with a stop watch and then at the end of a definite time in-

terval a scale reading was again taken. The fuel consumption was figured in terms of pounds per hour, pounds per brake-horsepower per hour, liters per hour, gallons per hour, brake-horsepower-hour per liter, and brake horsepower-hour per gallon.

Delivered horsepower: The delivered horsepower was calculated from the formula:

$$B.H.P. = \frac{WN}{2400}$$

where

B.H.P. = brake-horsepower.

W = represents the weight lifted in pounds by brake as read on dial.

N = speed in revolutions per minute.

and

2400 = numerical constant of the dynamometer.

Note that the delivered horsepower as determined does not include belt losses. Since it was not always possible to keep the engine running accurately at the rated speed, the deviation for a certain required power was not allowed to exceed ten revolutions above or below 1050. In like manner, the readings on the dynamometer dial were kept from deviating from the mean by not more than 0.25 pound. If the engine was discovered to be running irregularly for any required power, as shown by large variations in dynamo speeds and in lifted-weight readings, adjustments were made on all index settings, until a condition that would continue uniformly was attained with about the same capacity.

Belt slippage: Belt slippage was determined from the measured speeds of the engine pulley and of the dynamometer pulley. No correction was made on windage. Belt efficiency was not calculated. A small amount of belt dressing material was used.

Carbon deposits: The amount of carbon deposits in cylinder heads, cylinder walls, piston heads, piston walls, pistons, rings, ring grooves, and in spark plugs was measured by weight. It was necessary to remove one of the pistons each time an over-hauling was made in order to determine the amount of carbon in walls, in rings, and in grooves. Blunt instruments were used to remove the carbon. In cleaning the cylinder heads, special attention was given to valve heads and valve pockets.

Piston rings wear: The piston rings were scrubbed with brushes and washed with ether to remove any carbon, grease or oil. Each ring was weighed on the analytical balance and the difference between this weight and that previous to the test was re-

ported as the wear for that particular fuel used. When the rings were removed for the first time, they were carefully marked to avoid inverting them or interchanging their positions.

Relative humidity: From the recorded difference of temperatures between the wet and the dry bulb thermometers of the sling psychrometer, the percentages of relative humidity were calculated. Relative humidity tables as provided by the Taylor Instrument Companies were used as references. No correction for barometric pressure was made.

Brake thermal efficiencies: The brake thermal efficiencies were computed from the formula:

$$B.T.E. = \frac{2545}{W \times H} \times 100, \text{ where}$$

$B.T.E.$ = brake thermal efficiency in percentage calculated from measurements given in test data.

2545 = the heat equivalent of 1 horsepower hour in *B.t.u.*

W = the weight in pounds of the fuel consumed per brake horsepower hour.

H = heating value in *B.t.u.* per pound.

Corrosive effects: Corrosive effects were determined by ocular inspection of all the fresh-fuel passage ways, cylinder walls, piston walls, and exhaust-gas exits.

Oil consumption: Three items were considered in finding the amount of lubricating oil consumed; namely, (1) volume of new oil (O_n); (2) volume of old oil (O_u); and (3) per cent of dilution (P_d). After a certain fuel-test was made, which in most cases lasted twenty hours, all of the crank case oil was drained off. At least twelve hours were allowed for draining. Any amount of oil left in the oil pan that could not be removed by gravity was gathered when the engine was prepared for overhauling. The volume of the oil was measured at room temperature. After overhauling the engine, new oil of known volume was poured in.

Oil consumption was computed according to the following equation:

$$O_c = O_n - (O_u - O_u P_d)$$

where O_c = volume of oil consumed
 O_n = volume of new oil
 O_u = volume of used oil
and P_d = per cent dilution

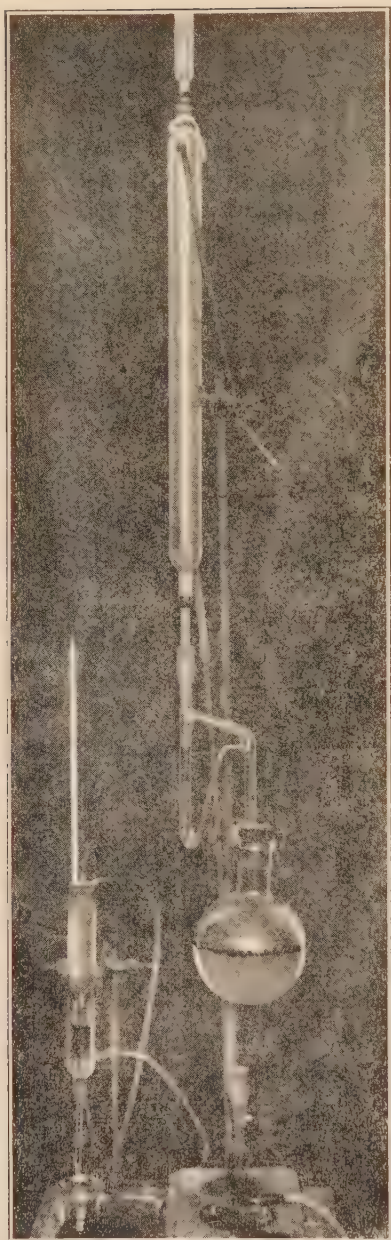


Fig. 3.—Different chemical apparatus used. *a.* dilution apparatus; *b.* viscosimeter.

Viscosity: Viscosities were determined as follows. The pipette (*see* fig. 3) was lowered until the tip dipped into the oil. By means of suction applied to the upper end, the oil was made to flow in and fill the pipette. The tip was then raised clear above the surface of the liquid and the oil made to flow out through the tip. As the falling surface of the oil up the stem of the pipette flowed past a fixed circular mark, a stop watch was started. Another circular mark at the lower stem indicated the end point and as the surface of the oil reached this mark the stop watch was stopped and the total time interval noted. This time, in seconds, divided by the value when water was used in the apparatus gives the relative viscosity.

Dilution: Dilution was determined by the ASTM method D322-30T (*see* fig. 3). Briefly, the method is as follows: Five hundred cc. of water are placed in a one-liter round bottom flask and 25 cc. of the oil sample measured in a 25 ml. graduated cylinder are added to the water. The flask is connected to a special receiver which in turn is connected to a reflux condenser cooled by running tap water. Heat is applied to the flask and so regulated that refluxing starts within 7 to 10 minutes. The oil itself is not volatile with steam. The diluent and steam rise up in the condenser and are refluxed back to the receiver or trap. Owing to its higher specific gravity the water falls to the bottom of the receiver and flows slowly back to the flask. The diluent remains trapped float-

ing above the water in the receiver. The volume of the diluent is read off directly. When low dilutions are expected and near the completion of every determination, readings are taken every fifteen minutes. For high dilutions, readings are taken at 30-minute intervals. The fluidity of the oil gives a rough approximation of the dilution. The test is considered completed when the volume of the diluent distilled over does not increase by more than 0.1 ml. in a 15-minute interval. Final readings of the volume are taken after the distillate has acquired room temperature. The volume thus obtained multiplied by four gives the percentage dilution, because the amount of sample taken for analysis is 25 cc., or one-fourth of 100.

Specific gravity: Specific gravities of the fuels were determined by cooling the samples to 15°C. by means of ice and water and measuring the values directly by the hydrometers. The specific gravities of the oils were taken at room temperature.

Heating values: The heating values of the hydrocarbon fuels were roughly calculated by the formula:

$$B.t.u. \text{ per lb.} = 18,650 + 40 \times (\text{Baumé reading} - 10)$$

The heating values of motor alcohol were estimated from the known calorific values of the different ingredients.

RESULTS AND DISCUSSION

The rated belt rating load was 36 horsepower. This was considered about 90 per cent of the maximum horsepower actually obtained for a short period on belt running using pure kerosene.

The proportion of air-fuel mixture was judged not by measuring the quantity of air supplied to the carburetor nor by analyzing the exhaust gases but by the performance of the engine, and by the appearance and smell of the exhaust gases.

Tables 1 and 2 show some of the characteristics of the fuels used and of the number of experiments carried out.

Effect of water injection

Operation with pure kerosene was very satisfactory. More injection water was needed to keep the engine running constantly on a lighter kerosene than on a heavier one.

Engine performance with the use of one part crude oil and three parts pure kerosene was very good. Any tendency of the engine to "pink" was easily remedied by the injection of a small amount of water. When operating normally on a high load and injection water was decreased slightly, a momentary increase in load immediately became evident, but, as soon as the engine became heated up again the power decreased and continued to decrease even below

the required capacity. The addition of a small amount of injection water at this point had the effect of restoring it to normal operation.

Running with mixtures having equal amounts of pure kerosene and of crude oil was fairly satisfactory. Careful attention was given, however, to the amount of injection water. Only so much was used, as a little excess caused a decrease in power and a corresponding increase in fuel consumption.

Only one hydrocarbon fuel failed to operate the engine at its normal capacity; this was a mixture of one part pure kerosene and three parts crude oil. It was impossible to reach the normal load with the use of this fuel. Fractional load tests using this fuel were characterized by occasional engine missing, slight pounding, and dark exhaust gases. Attempts to minimize the formation of black smoke by increasing the injection water diminished the power and increased the consumption.

Trials with the use of pure crude oil also failed because the engine was only able to operate for a few minutes and without any load on this fuel. Even with the injection of a liberal amount of water, the exhaust gases were black and full of free carbon.

Consumption and power

The following deductions may be made from the data presented in tables 3, 4, and 5 and from the curves in chart 1.

1. With respect to power and economy, 75 per cent pure kerosene plus 25 per cent crude oil gives quite as good a result as pure kerosene.

2. The consumption per brake horsepower increases with decrease of load below the rated capacity. The relative increases vary from 6 to 13 per cent in three-fourths load, from 24 to 37 per cent in half load, and from 88 to 113 per cent in one-fourth load.

3. The consumption per brake horsepower hour increases with increase of the amount of crude oil in kerosene-crude oil combinations. With mixture having equal volumes of kerosene and crude oil, an increase of from 6 to 10 per cent is obtained. With 75 per cent crude oil the increase in fuel consumption at fractional load is nearly 50 per cent.

4. The equivalent amount of motor alcohol fuels used in terms of the consumption of pure kerosene varies from 1.20 to 1.30. The difference in these fuels was due to the percentage of gasoline present in the mixtures.

5. With the pre-heating device set to utilize all the available heat, as arranged in kerosene, an economy of from 0.4 to about 6 per cent is noted from beginning half load to about quarter load with

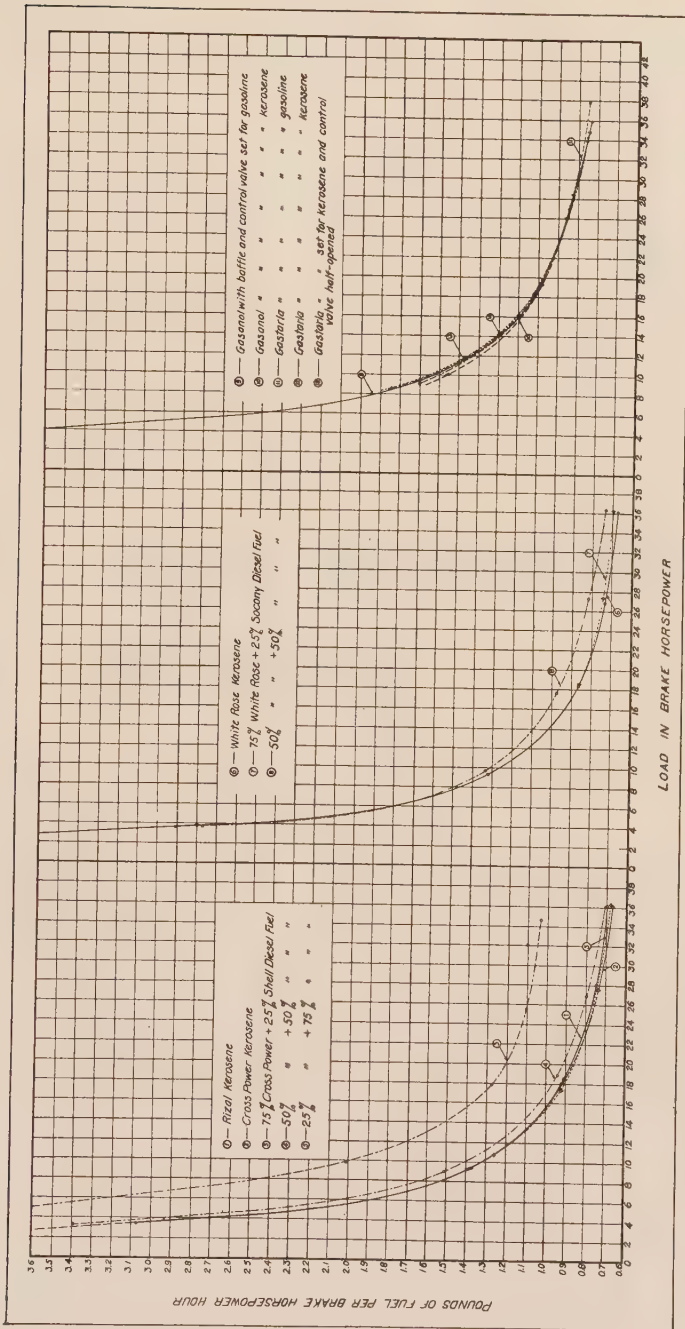


Chart. 1.—Curves showing relation between consumption of fuel in pounds per brake horsepower hour and load in brake horsepower.

the use of Gasanol and from 1 to 2.2 per cent using Gastarla. At and around three-fourths load, the consumption is almost the same as without any pre-heating. With medium pre-heating and using Gastarla alone the saving is from 1.7 per cent at three-fourths load to about 3.9 per cent at one-fourth load.

6. Only the mixture containing one part of pure kerosene and three parts crude oil does not show any result on normal capacity. The same is true with Gasanol and with Gastarla when pre-heating was applied.

7. Tests using the optimum carburetor opening for the required power shows some slight economy if compared with the tests using the optimum carburetor opening for the normal load. The difference which is hardly over $1\frac{1}{2}$ per cent from one-fourth load to three-fourths load is maximum near the half load.

8. After more than 100 hours of operation from the time the engine was considered "broken-in", the data in fuel consumption, as shown by special tests, show a decrease of from 8 to 12 per cent at the most economical point using pure kerosene, about 7 per cent using kerosene-crude oil mixtures, and a little over 2 per cent using motor alcohol.

Short tests showed that a maximum of slightly over 40 horsepower could be reached and probably could be maintained for a longer period when Gasanol and Gastarla were used. The highest point reached with Gasanol was better than Gastarla by about 0.4 horsepower. Pure kerosene and mixtures of one part crude oil and three parts pure kerosene registered slightly 2 per cent less. The 50-50 mixture could not exceed the rated power by one horsepower. It was doubted, however, if the hydrocarbon fuels could maintain the maximum points reached had the engine been made to continue to operate.

The behavior of the engine using alcohol fuels was as highly satisfactory as when using pure kerosene. Starting from cold was accomplished any time of the day. It was not possible, however, for the engine to continue to maintain the normal capacity when pre-heating was applied. For a minute or so after the engine had started from cold, it could carry a load even beyond the normal rating. As soon as the engine got warmed up and with pre-heating on, the power decreased slowly and the speed diminished.

Note that in attempting to reach the maximum power that could be developed, the engine using hydrocarbon fuels not only showed signs of being overworked but also consumed lots of fuel. The carburetor opening had to be turned wide-open to provide the rich mix-

ture necessary for the required power. In the case of the alcohol fuels, however, no sign of laboring was exhibited and the consumption per brake horsepower hour decreased. The relative consumption between motor-alcohols and pure kerosene at the maximum points were almost equal after the engine had started from cold and had a tendency to become more economical in alcohol fuels than in pure kerosene after several minutes of operation. It could also be felt that the radiated heat from the engine was greater in hydrocarbon fuels than in alcohol fuels when operating at these points.

It should also be noted that it was extremely difficult to find the carburetor setting that gave the most economical point in alcohol fuels for the desired power. This was true, especially, when pre-heating was attempted. Difficulty was met more at low loads than at high loads, probably because of the high latent heat of vaporization and of the wide range of combustibility of alcohol mixtures.

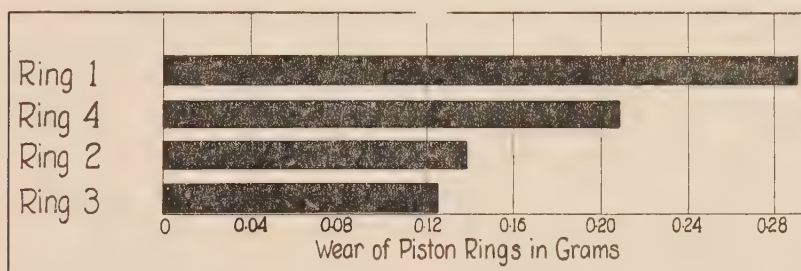


Chart. 2.—Relative distribution of ring wear.

Ring wear

Since the rings were tightly pressed against the cylinder walls, usage caused them to become undersized. Their contact with the hot walls produced variable effects on the degree of wear because of their relative positions. Each cylinder of the engine tested was provided with three compression rings and one oil-control ring or scrape ring. The scrape ring was placed below and was provided with an annular groove.

Table 6 and charts 2, 3, and 4 show the results of ring wear. From the data given the following may be deduced:

1. The wear is largest in the compression ring closest to the piston head, averaging about 38.2 per cent of the total ring wear. Less than one-half of this amount falls on each of the other two compression rings and one-third less on the oil-control ring. The wear on No. 2 compression ring exceeds that of No. 3 by about 2 per cent.

2. There is a definite indication that the rate of wear decreases as the time of engine run increases. (See chart 3.)

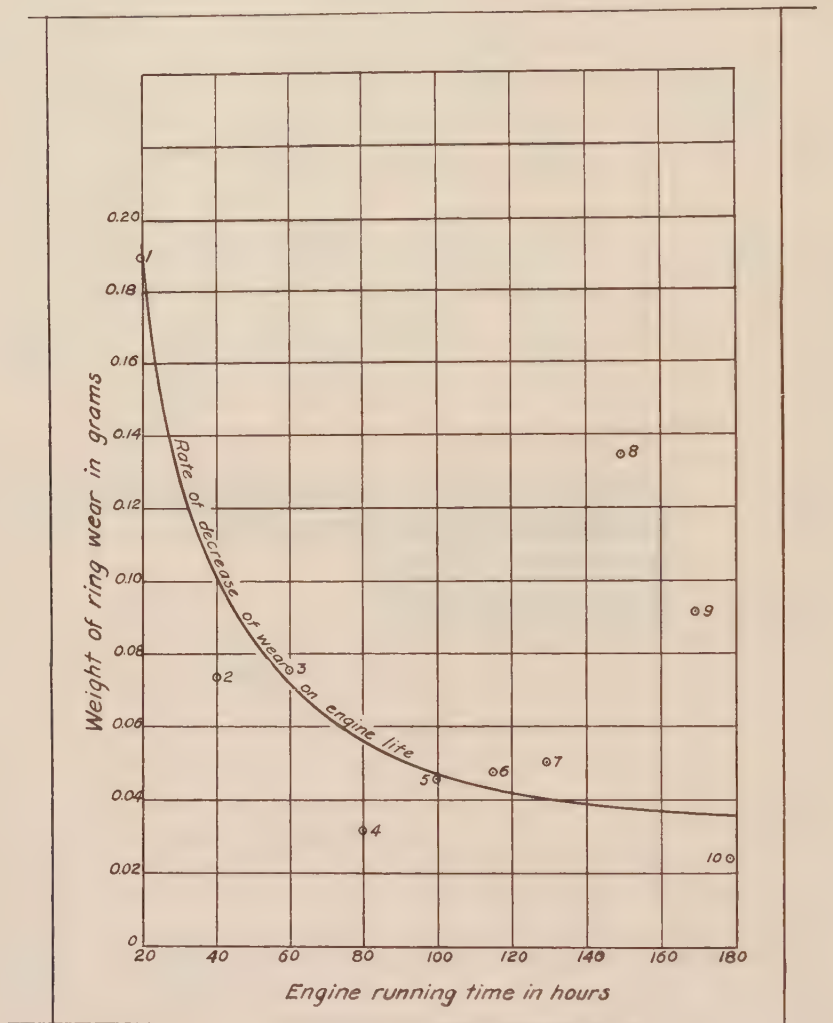


Chart. 3.—Rate of decrease of ring wear in engine life. (1) Cross Power; (2) Gasanol; (3) 50% Cross Power + 50% Shell Diesel; (4) Gastarla; (5) 75% Cross Power + 25% Shell Diesel; (6) Miscellaneous tests; (7) 25% Cross Power + 75% Shell Diesel; (8) White Rose; (9) 50% White Rose + 50% Socony Diesel; and (10) 75% White Rose + 25% Socony Diesel.

3. The greater the percentage of crude oil in the mixture of pure kerosene and crude oil, the larger is the wear at various periods

in engine life. (See table 7 and chart 4.) In 180 hours of running, the calculated increase in wear is from 3 to 10.4 per cent in mixture with 25 per cent Diesel fuel; from 8 to 24.5 per cent in 50-50 mix-

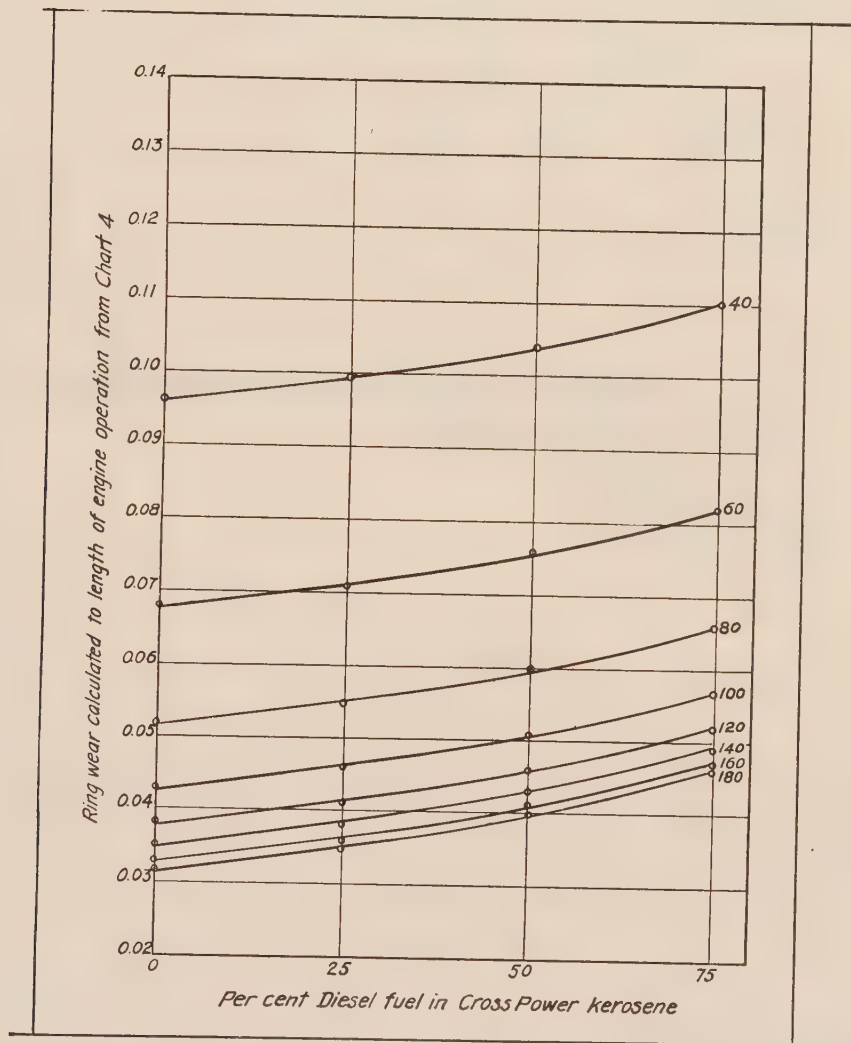


Chart. 4.—Effect of percentage of Diesel fuel in pure kerosene on ring wear at various periods in engine life.

ture; and from 10.5 to 46 per cent in mixture containing 75 per cent crude oil.

4. When using alcohol fuels, wear is not excessive.

Carbon deposit

Dry, powdered carbon was collected when hydrocarbon fuels were used. The exhaust valves were found almost clean when using pure kerosene; they showed, however, some signs of being overheated. Although considerable carbon was noticed in the spark plugs when the percentage of crude oil was increased in the kerosene-crude oil combination, no stoppage of the engine was recorded as due to fouling. Larger particles of carbon deposit were scraped off after operating with the heavier combinations.

Damp, flaky, and somewhat sticky deposits covered the piston heads and cylinder heads when alcohol fuels were used. The exhaust valves did not show sign of being overheated, but the stems showed definite evidence of gumming up. Thin layers of carbon were found on the valve heads. The inlet valve pockets and heads were the

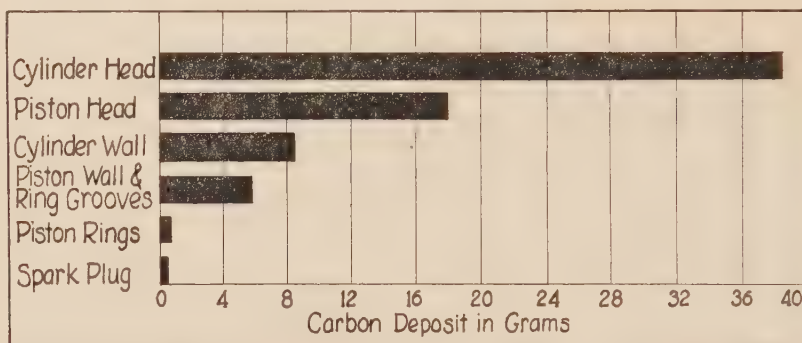


Chart. 5.—Relative distribution of carbon deposit.

most heavily coated and some of the particles were slightly gummy. Even some portion of the inlet valve stems showed signs of being carbonized. Examination revealed very clean pistons walls, cylinder walls, and spark plugs.

A study of table 8 and of chart 5 will show the following deductions:

1. That there is a definite increase of carbon deposit in proportion to percentage of crude oil added to pure kerosene. Note that with the mixture containing equal proportions of kerosene and of Diesel fuel, the increase was about 100 per cent by weight.

2. Alcohol fuels give a large deposit on cylinder and piston heads. Gasanol and Gastarla have each more than 85 per cent of their total carbon deposit on the heads alone.

3. Carbon deposit in spark plugs is heavy with the use of mixtures of pure kerosene and Diesel fuel.

Dilution

The term "new oil" refers to the fresh, selected brand of oil that was used in the crankcase each time a certain kind of fuel was tested. "Used oil" was the liquid found in the crankcase at the completion of any fuel test. No attempt was made in this investigation to analyze the ingredients of the "used oil" nor those of the sludge. The term "dilution" was applied to indicate the presence of light oils which caused the lubricant to thin out. Owing to incomplete combustion of a fresh charge it was assumed that some of the vapors absorbed by the lubricant in the cylinder walls found their way past the piston rings to the crankcase, and finally diluted the whole body of the oil. Thus, dilution has an adverse effect on the engine life, since the fuel, in passing the piston, washes off the lubricating oil and hence increases the wear. Effect of factors like load, fuel combustibility, temperature of engine and lubricating oil, volatility of fuel, mechanical condition of the engine, and amount of injection water, could not be controlled with the present apparatus.

In table 9 are shown the results of study on lubricating oil regarding change in specific gravity, dilution, viscosity and consumption.

An examination of columns 2, 3, 4 and 5 of this table will give the following deductions:

(1) That dilution has lowered the specific gravity of the lubricant.

(2) To consider the change in specific gravity as an index of dilution can hardly be depended upon.

(3) That dilution seems to be rapid in the first few hours. Note the difference of only about 0.5 per cent dilution in alcohol fuels after 10 hours and 20 hours.

(4) It is indicated that, all other things being equal, the higher the percentage of crude oil in the mixture of pure kerosene and Diesel fuel, the greater is the dilution.

(5) That dilution is very much less for alcohol mixtures than for kerosene-crude oil combinations.

Note that after 10 hours of operation the dilution of oil for mixture containing 75 per cent crude oil was 70 per cent. It was doubted if the engine could continue to operate and maintain the required load without doing any damage to bearings, cylinders, and pistons. It was observed near the end of the run that because of increased volume, part of the lubricating oil was going out through the breather of the crankcase.

The data given in column 7 are too few and the method used in determining the temperature too inaccurate to permit making deductions on the effect of temperature on dilution. It is indicated, however, that the higher the temperature the less the dilution.

Consumption of lubricating oil

It is evident from the figures presented in columns 8, 9, and 10 of table 9 that:

(1) The larger the dilution the smaller is the rate of consumption. This is due to the fact that the lubricating oil pumped by the piston into the combustion chamber and burnt contains a percentage of diluent. Consequently, the higher the dilution the less the actual quantity of pure lubricating oil consumed. This result cannot be taken as an economy as the reduction in pure lubricating oil and the washing of the piston increase the wear of the engine to a considerable degree.

(2) The volume of used oil does not always show a decrease in amount after the engine has run for several hours. Tests on fuels having equal volume of crude oil and pure kerosene show an increase of 50 per cent over the original volume. With 75 per cent crude oil, the increase is over 2.2 times. Decrease in volume is shown by those fuels having less dilution.

(3) The amount of increase or decrease of used oil cannot be used as an index of dilution, unless the tendency to dilution of the fuel is known.

Viscosity

The figures given in the last two columns of table 9 show the following results:

(1) Dilution causes the lubricating oil to become less viscous.

(2) Viscosity shows indication that, for the same diluent, it can be used as an index of dilution provided all other influencing factors are the same.

Brake thermal efficiencies

From the given calculated data of thermal efficiencies in table 3, the following deductions may be made:

(1) There is a definite decrease in thermal efficiency as the load decreases from the normal load in hydro-carbon fuels and from the maximum load in alcohol fuels. The hydro-carbon fuels are not as efficient at the maximum point as at or near the normal load.

(2) Mixtures containing 25 per cent crude oil are as efficient as pure kerosene as the load decreases from about 60 to 75 per cent

of the normal capacity. Beyond these points, the efficiencies of pure kerosene do not exceed those of the mixture given above by more than 0.6 per cent.

(3) There is a definite decrease of efficiency as the percentage of crude oil is increased in the hydro-carbon mixtures. The decrease is between 40 and 50 per cent in the mixture containing one part kerosene and three parts crude oil.

(4) The thermal efficiencies of alcohol fuels are, in general, higher than those of hydrocarbon fuels.

(5) Slight increase in efficiency is noted where the carburetor opening is optimum for the required power.

(6) The thermal efficiency is high on all points where the consumption of fuel shows a decrease in value due to any kind of pre-heating.

(7) There is a decided increase in efficiency for all special tests that were repeated after more than 100 hours of engine operation.

Corrosion and rusting

Very little sign of scoring of rings and of pistons was evident after the tests on mixtures containing 50 per cent and 75 per cent crude oil. On alcohol fuels equally as light, evidence of corrosion was observed on some exhaust valve stems and in muffler. It is believed that the former was caused by the presence of too much carbon in the combustion chamber and by improper lubrication, caused by washing of the piston by the diluent, and the latter by the injection water and acidic products of combustion of alcohol fuels. The tests were not specially for these points, and were not of sufficient duration to make the observation of value except as an indication of what might take place with continued running.

Belt slippage

Proper precautions were carried out to minimize belt slippage. The maximum value calculated was about 1.7 per cent. The tests showed that without retightening the belt, slippage decreases as the load was lowered.

Miscellaneous observations

No attempt was made to find the effects of changes of relative humidity, barometric pressure, and room temperature on the consumption and on power developed.

Fuel and oil costs

A study of table 10 will show that the most economical fuel is Cross Power if selection is based on the consumption expressed in

pounds per brake horsepower-hour at full load. At or near the half load, and below, White Rose shows the least consumption. Present practice deals with cost of fuel per given volume, as per liter or per gallon, and not per given weight; a fuel that proves the most economical per weight basis may not necessarily turn out the most economical per volume basis. Figures presented in columns 13, 14, 15, and 16 of summary table 10 will show that on account of differences in the densities of the different fuels, the mixtures containing 25 per cent crude oil proved in the test to be the most economical.

Considering the cost per unit volume of the cheapest kerosene as unity, the equivalent minimum cost of the other fuels may be computed as shown in columns 17 and 18.

In figuring the cost of lubricating oil, factors such as dilution, viscosity, and tendency to keep on as ideal lubricant cannot be disregarded. The cost certainly will differ depending upon the quality of the product and on the change of the body of the oil. If an oil with too low viscosity is used, fuels with tendency to turn out large dilution may lower it to such a degree that the engine life will be shortened owing to seizing of the moving parts. On the other hand, alcohol fuels may thicken the oil after many hours of operation. A rule may thus be followed, that is, start with more viscous oil for fuels tending to cause large dilution and with lighter oil for fuels tending to cause less. Only actual experience and practice coupled with outside valuable information can guide users of lubricating oil in selecting the most economical oil for the particular engine and work they are handling.

SUMMARY AND CONCLUSIONS

It was the main object of this investigation to obtain as much information as possible on the possibility of adapting not only kerosene-crude oil combination in various proportions but also alcohol-gasoline mixtures as fuels for the types of multicylinder engines used at present for farm tractors. The McCormick-Deering Industrial Unit which was used in all of the tests readily proved its worth as an efficient, economical, and dependable prime mover. The different fuels used, all of which are available in the Philippine market, certainly offered very interesting results when experimented with as to consumption, power, economy, carbon deposit, and tendencies either to detonate, to cause wear, or to dilute the lubricating oil.

As a preliminary to further work, data on piston rings wear, carbon deposit, dilution, and viscosity of lubricating oil were gathered. Because the results obtained on these points were so few, whatever

deductions were made should be considered only as definite information leading to further tests with better methods of procedure and with specially designed apparatus.

The results of tests using pure kerosene and mixtures of kerosene and crude oil justified the presence of water injection attachment to the carburetor. All the hydrocarbon fuels tested not only needed different amounts of injection water to suppress or minimize fuel knock but also to cause the engine to produce unequal consumption per brake horsepower hour at equal load. Thus, the amount of injection water may be considered as an indication of the anti-knock qualities of the fuels. Operation with these fuels for a long period at or near the normal load would not be possible without water injection to keep the temperature of combustion chamber at a suitable degree. When injection water was added, however, in excess quantities the resulting effects were unsteady running of the engine, occasional missing, poor economy, and loss of flexibility.

Results with pure kerosene showed that the maximum power developed was the highest in the hydrocarbon groups, and that the tendency to detonate, to cause carbon deposit, and to produce dilution was at the minimum. The use of mixtures of kerosene and crude oil not only give an increase in consumption but also a greater tendency to produce carbon, increase wear, decrease power, and dilute the crank case oil. These tendencies increase as the percentage of Diesel fuel increases. Owing to the large increase in fuel consumption, loss of power, and unsteadiness in engine operation, running the engine on a mixture having 75 per cent Diesel fuel was questionable. With this fuel, lubrication trouble might be met on account of extremely high dilution.

The alcohol-gasoline blends gave the engine a most satisfactory operation. The running was characterized with great steadiness, silence, and absence of fuel knocks. Greater maximum power was obtained owing to high latent heat of vaporization. The thermal efficiency was equally high. The response to load pick-up was rather slow and there was a tendency to have the carbon deposit accumulated on the cylinder and piston heads, and to gum or corrode the exhaust valve. Wear was not excessive and dilution was very small. Engine lubrication along cylinder walls and piston ring was good. The high rate of lubricating oil consumption coupled with the effect of thickening the used oil are worth considering to keep guard on the possibility of drying up the parts that need proper lubrication. Although the evidence of corrosion was slight, because of short length of time the engine was run with these fuels, indications of the ex-

haust valve stems and of the muffler to become corroded, is unfavorable and may militate against their use. This is a matter for further experiment. Owing to the wide range of mixture proportion of alcohol-gasoline mixture, it was rather difficult to find the point giving the most economical fuel consumption for the required power. It was easily possible to double the consumption by a slight maladjustment of the carburetor setting.

Pre-heating alcohol fuels proved an advantage at low loads because of the resulting better flexibility and lower consumption. At high loads, however, extra heat caused not only a decrease in volumetric efficiency with a corresponding loss of power, but also unsteadiness in engine operation.

Attempts to find certain relations between specific gravity, dilution, viscosity, ring wear, and carbon deposit resulted in accumulating data that will be a valuable basis for further experiments. Data were obtained which showed the trend of the above factors. With small variations, increase in dilution indicated a definite decrease in specific gravity and in viscosity of the lubricating oil. To use these two factors as an index of dilution is subject to criticism for effects of factors like metallic particles caused by wear, free carbon from fuel and lubricating oil, products of oxidation, decomposition of the fuel and the amount of injection water were variable factors which could not be determined with the present apparatus. Except for the diluent which thins out the lubricating oil, all the other factors will affect the specific gravity and viscosity to a considerable extent.

The aging of the engine expressed in number of hours of operation from "breaking in" period and the piston ring wears showed that it was possible to obtain from the same fuel wide variations in fuel consumption per brake horsepower-hour at equal load. After more than 100 hours of operation an economy of from 2 to 12 per cent was realized. The largest decrease was in the first fuel tested. From the same data, it was also deduced that the greater the percentage of crude oil in the kerosene-crude oil combination, the greater was the ring wear calculated to length of engine operation, and the higher the dilution and carbon deposit.

The results of the tests on hydrocarbon fuels show that although a mixture containing 25 per cent Diesel fuel in kerosene is slightly more economical than pure kerosene, as to fuel cost, this small advantage will be outweighed by the decrease in engine life,

as indicated by the ring wear, and the more frequent necessity for overhauling, as indicated by the carbon deposit figures. Again, the increase in dilution will necessitate more frequent changes of lubricating oil.

Since ease of starting and flexibility under varying loads are not of primary importance in stationary engines and farm tractors, the alcohol-gasoline combination of the kinds tested in this investigation may have a considerable field as fuels for engines originally designed for kerosene. To be equally as economical as the most economical hydrocarbon fuel, the cost to the consumer must not exceed the computed relative equivalents as given in table 10, but, it must be pointed out that care must be taken to obtain the carburetor setting suitable for the fuel.

With compression ratio of 4.42 to 1 using McCormick Deering multicylinder engine the alcohol-gasoline combinations gave slightly higher brake thermal efficiency than the hydrocarbon fuels.

The Golden Shell lubricating oil gave very satisfactory service throughout the tests and showed no sign of breaking down even under the most adverse conditions.

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TABLE 1
Showing some of the physical properties of the fuels used

NAME OF FUEL	SPECIFIC GRAVITY	WEIGHT		APPROXIMATE HIGH HEATING VALUE ^a	SOURCES
		per liter	per gallon		
Rizal	at 15°C.	lb.	lb.	B.t.u. per lb.	
Cross Power	0.817	1.797	6.80	19,908	Asiatic Petroleum Company
75% Cross Power + 25% Shell Diesel	0.846	1.861	7.04	19,670	
50% " " + 50% " "	0.871	1.916	7.25	19,480	
25% " " + 75% " "	0.875	1.925	7.28	19,450	
	0.887	1.951	7.38	19,364	
White Rose					Standard Oil Company
75% White Rose + 25% Socony Diesel	0.801	1.762	6.67	20,041	
50% " " + 50% " "	0.807	1.775	6.72	19,989	
	0.828	1.822	6.89	19,813	La Tondena
Gasanol	0.779	1.714	6.48	15,379	
Gastarlia	0.786	1.729	6.54	14,928	Central Azucarera de Tarlac

^a Calculated.

TABLE 2
Number of tests carried out

NAME OF FUEL	NUMBER OF TESTS							TOTAL OF TESTS	DURATION OF TESTS	TOTAL PERIOD OF SERIES A AND B
	SERIES A		SERIES B		SPECIAL					
	With fixed carburetor opening	With fixed carburetor opening	With variable carburetor opening	Repeated test	Medium heat on	Full heat on				
Rizal	1	5	6	6	6	—	—	18	1358	20.0
Cross Power	1	5	4	4	5	—	—	15	1278	20.0
75% Cross Power + 25% Shell Diesel	1	5	4	4	—	—	—	10	1139	20.0
50% " + 50% "	1	5	4	4	5	—	—	15	1274	20.0
25% " + 75% "	1	4	6	6	—	—	—	11	773	14.5
White Rose	1	4	4	4	—	—	—	9	1130	20.0
75% White Rose + 25% Socony Diesel	1	5	3	3	—	—	—	9	513	9.0
50% " + 50% "	1	5	4	4	—	—	—	10	1140	20.0
Gasanol	1	5	7	7	6	—	4	23	1362	20.0
Gastarla	1	6	7	7	5	4	5	28	1434	20.0
Total	10	49	49	49	27	4	9	148	11401	183.5

TABLE 3
Results of engine tests showing observed and calculated data

TEST NO.	AVERAGE SPEEDS		DY- NAMOMETER LOAD	TEMPERATURES				BAROMETERIC PRESSURE		INDEX READINGS		DURATION OF TESTS	DE- LIVERED HORSE POWER	FUEL CONSUMPTION			BRAKE THERMAL EFFICIENCY	BELT SLIP-PAGE	RELATIVE HUMIDITY	REMARKS	
	Engine meter	r.p.m.		Cooling water	Room	Psychrometer		Carburetor	Throttle Ignition	lb. per hour	l. per hour			b.h.p. per gal.	b.h.p. per hr.						
						Dry bulb	Wet bulb									notches					notches
			lb.	°C.	°C.	°F.	°F.	tches of mercury	notches	notches	notches	min-utes					per cent	per cent			
Rizal kerosene Sp. gr. = 0.817																					
26	1042	1032	84.50	88.0	36.0	95.0	79.0	30.00	i-29/64	Full=21	Full=21	500	36.40	29.22	16.28	8.46	0.803	15.90	0.96	49.0	Tests after considering the engine "broken in"
27	1050	1044	7.25	62.0	30.0	86.0	75.0	30.06	"	5	Full	120	3.15	13.02	7.24	1.64	4.130	3.10	0.57	60.0	
28	1051	1044	20.75	70.0	32.0	90.0	77.0	30.06	"	7	6	120	9.02	17.88	9.95	3.43	1.980	6.45	0.67	56.0	
29	1050	1040	42.25	78.0	32.5	89.0	77.0	30.03	"	8	Full	120	18.30	19.08	10.61	6.52	1.041	12.26	0.95	58.5	
30	1048	1034	63.30	80.0	34.0	98.0	78.0	30.00	"	12	"	120	27.26	23.88	13.28	7.77	0.875	14.60	1.33	51.5	
31	1048	1040	20.80	69.0	32.0	90.0	79.0	30.00	"	6	"	36	9.01	14.64	8.15	4.18	1.625	7.86	1.03	62.0	
9	1048	1030	84.90	84.0	30.0	91.0	79.5	29.90	i-28/64	Full	"	30	36.40	28.20	15.68	8.79	0.774	16.50	1.71	60.5	
10	1043	1028	68.10	90.0	31.8	90.0	78.0	29.90	i-17/64	13	"	33	29.15	21.50	11.95	9.23	0.737	17.33	1.43	59.0	
11	1055	1046	46.50	83.5	33.0	91.0	80.0	29.90	i-10/64	10	"	30	20.20	16.78	9.32	8.21	0.829	15.40	0.85	62.0	
12	1053	1045	24.80	77.0	32.0	89.0	77.0	30.50	i-11/64	8	"	36	10.78	13.74	7.64	5.33	1.276	10.00	0.76	58.5	
19	1054	1047	12.23	69.5	31.0	86.0	76.0	30.50	i-11/64	7	"	24	5.32	12.62	7.03	2.86	2.372	5.38	0.66	63.0	
20	1048	1043	5.08	66.5	30.5	89.5	77.0	29.90	i-11/64	6	"	21	2.21	11.35	6.32	1.32	5.137	2.49	0.48	57.2	
78	1054	1042	82.50	91.0	27.0	80.0	78.5	29.90	i-19/64	Full	"	27	35.83	25.00	13.91	9.75	0.697	18.33	1.13	86.0	
79	1054	1041	83.00	92.2	28.8	82.5	78.5	29.90	"	"	"	30	36.00	24.90	13.84	9.83	0.692	18.40	1.23	84.0	
80	1052	1043	64.30	89.0	29.2	85.0	80.0	29.91	"	11	"	30	27.95	20.90	11.63	9.09	0.748	17.07	0.85	80.5	
81	1047	1033	42.80	80.0	30.0	85.0	80.0	29.92	"	8	"	30	18.42	16.60	9.24	7.55	0.901	14.18	1.34	80.5	
82	1048	1042	21.30	70.0	30.5	86.5	81.5	29.92	"	6	"	30	9.25	12.80	7.12	4.98	1.384	9.23	0.57	81.0	
83	1050	1043	8.00	69.0	30.3	87.0	81.0	29.90	"	5-1/2	"	21	3.48	10.70	5.95	2.21	3.075	4.15	0.67	77.5	

TABLE 3—Continued

TEST NO.	AVERAGE SPEEDS		DY- NAMO- METER LOAD	TEMPERATURES				BAR- OMET- RIC PRES- SURE	INDEX READINGS		DURA- TION OF TESTS	DE- LIVER- ED HORSE POWER	FUEL CONSUMPTION				BRAKE THER- MAL SLIP- EFFI- CIEN- CY	BELT FACE DUM- PITY	REMARKS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
	En- gine	meter		Cool- ing water	Room	Dry bulb	Wet bulb		Car- buretor	Throttle			Ignition	lb. per hour	l. per hour	b.h.p. per gal.				lb. per hr.	b.h.p. per hr.	per cent	per cent																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
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			lb.	°C.	°C.	°F.	°F.	inches of mer- cury			min- utes																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							</

75% Cross Power + 25% Shell Diesel fuel Sp. gr. = 0.871

	1052	1038	84.00	89.0	82.0	78.0	29.88	1-16/64	Full	Full	600	36.36	24.66	12.86	10.70	0.678	19.25	1.33	84.0
66																			
71	1042	1036	7.00	68.0	84.0	80.0	29.90	"	5-1/2	"	120	3.02	10.62	5.54	2.06	3.510	3.72	0.57	83.0
72A	1043	1035	21.50	70.5	83.0	77.5	29.90	"	6-1/2	"	60	9.27	12.96	6.76	5.18	1.399	9.33	0.76	80.0
72B	1045	1046	25.00	70.5	84.5	80.5	29.90	"	7	"	54	10.88	13.62	7.11	5.79	1.251	10.43	0.85	84.0
73	1045	1033	40.50	77.0	83.9	78.0	29.83	"	8	"	100	17.43	15.96	8.33	7.90	0.916	14.25	1.15	73.0
74	1051	1041	63.80	88.0	85.5	79.5	29.82	"	12	"	100	27.67	20.46	10.67	9.81	0.739	17.66	0.95	77.0
67	1044	1034	68.50	82.0	78.0	77.0	29.90	1-11/64	14	"	30	29.50	20.60	10.75	10.38	0.698	18.70	0.96	96.0
68	1049	1041	47.30	78.0	78.0	77.0	29.90	1-15/64	9	"	30	20.52	16.60	8.66	8.96	0.809	16.14	0.76	96.0
69	1046	1039	23.90	71.0	77.0	76.0	29.90	1-10/64	7	"	24	10.35	13.20	6.89	5.68	1.275	10.24	0.67	96.0
70	1051	1045	13.00	65.0	77.0	76.0	29.90	1-7/64	7	"	21	5.66	12.00	6.26	3.42	2.120	6.16	0.57	96.0

Regular tests
following
Gastarla
group

50% Cross Power + 50% Shell Diesel fuel Sp. gr. = 0.875

	1052	1040	85.00	99.0	95.0	81.0	30.04	1-30/64	Full	Full	480	36.83	27.90	14.49	9.62	0.757	17.27	1.14	54.5
49A																			
49B	1055	1043	83.00	91.0	92.0	78.0	29.94	1-23/64	"	"	120	36.08	27.45	14.26	9.57	0.761	17.18	1.14	54.0
50	1052	1047	6.90	64.0	85.0	78.0	30.01	"	5	"	100	3.01	11.88	6.17	1.84	3.952	3.31	0.47	41.5
51	1053	1045	20.50	68.0	87.0	78.0	30.02	"	6	"	100	8.53	14.82	7.70	4.19	1.738	7.52	0.76	67.0
52	1052	1042	42.80	78.5	94.0	79.0	30.02	"	8	"	100	18.59	18.18	9.44	7.45	0.978	13.37	0.95	82.0
53	1058	1048	64.15	85.0	95.0	79.0	29.94	"	11	"	120	28.00	28.68	14.89	7.11	1.023	12.77	0.94	50.5
54	1052	1039	70.00	88.0	93.0	79.0	29.94	1-12/64	15	"	30	30.30	22.00	11.42	10.03	0.726	18.00	1.23	54.0
55	1045	1033	45.00	80.0	92.0	79.0	29.94	1-3/64	11	"	30	19.37	17.00	8.83	8.29	0.877	14.90	0.76	57.0
56	1041	1032	23.00	75.5	84.0	78.5	29.92	1-2/64	7-1/2	"	30	9.89	13.20	6.86	5.46	1.335	9.80	0.86	57.0
57	1058	1051	11.30	73.0	91.5	78.5	29.92	1-2/64	7	"	20	4.95	12.00	6.24	3.00	2.422	5.40	0.66	59.0
100	1048	1038	83.60	97.0	93.0	79.5	29.94	1-20/64	Full	"	30	36.16	25.50	13.24	10.32	0.705	18.55	0.95	83.0
101	1055	1045	62.00	86.0	87.5	81.5	29.93	"	10-1/2	"	24	27.00	21.40	11.11	9.18	0.792	16.50	0.95	77.0
102	1054	1043	43.70	81.0	90.0	82.0	29.94	"	8	"	30	18.98	17.80	9.24	7.76	0.938	13.94	1.04	71.0
103	1052	1040	21.00	73.0	89.0	81.0	29.94	"	5	"	30	9.10	13.70	7.12	4.84	1.505	8.69	1.14	71.0
104	1049	1044	7.80	70.5	90.0	83.0	29.93	"	5	"	30	3.39	11.50	5.97	2.15	3.390	3.86	0.48	75.0

Regular tests
following
runs using
CasanolSpecial tests
after 100
hours of
operation

TABLE 3- Continued

TEST NO.	AVERAGE SPEEDS		DY- METER LOAD	TEMPERATURES			BAR- OMET- RIC PRES- SURE	INDEX READINGS		DURA- TION OF TESTS	Dis- LIVAB- LD. LOSS- LOWER	FUEL CONSUMPTION				BRAKE- THER- MAL EPHI- CIEN- CY	BELT- SLIP- PAGE	RELA- TIVE HUMI- DITY	REMARKS		
	En- gine	Dy- nano- meter		Cool- ing water	Room	Psychrometer Dry bulb		Wet bulb	Car- buretor			Throttle Ignition	min- utes	lb. per hour	l. per hr. pe. gal.					b.h.p. per hr.	lb. per b.h.p.- hr.
25% Cross Power + 75% Shell Diesel fuel Sp. gr. = 0.887																					
119	1043	1034	80.50	85.0	36.0	93.0	77.5	29.96	1-15/64	Full	540	34.70	36.00	18.43	7.12	1.037	12.66	0.86	57.0		
120	1045	1040	8.45	62.0	29.8	83.0	78.0	29.97	"	5-1/2	30	3.66	15.20	7.79	1.78	4.149	3.17	0.48	80.0		
121	1050	1040	23.00	65.6	30.5	84.0	78.0	29.97	"	7	30	9.97	20.00	10.25	3.68	2.010	6.53	0.95	77.0		
122	1050	1040	41.50	73.0	31.2	86.0	84.0	29.97	"	8-1/2	30	17.98	23.00	11.78	5.78	1.278	10.27	1.05	77.0		
123	1055	1042	59.00	76.0	32.0	89.0	80.0	30.00	"	12	30	25.61	28.20	14.45	6.70	1.100	11.95	1.02	67.5		
124	1055	1040	75.00	81.0	32.8	89.5	80.5	30.00	1- 7/64	19	18	32.50	32.60	16.70	7.34	1.028	12.77	1.42	68.0		
125A	1055	1045	56.00	79.0	33.5	91.0	80.0	30.00	1- 3/64	11	24	24.39	24.40	12.50	7.36	1.000	13.13	0.95	62.0		
125B	1056	1046	58.50	80.0	33.5	91.0	80.0	30.00	1	11	18	25.50	22.80	11.67	8.25	0.884	14.85	0.95	62.0		
126	1054	1042	38.00	79.0	34.5	94.0	90.0	30.00	62/64	8	30	16.49	18.40	9.43	6.62	1.115	11.42	1.14	85.0		
127	1051	1043	16.80	74.0	34.5	94.0	80.0	30.00	61/64	6-1/2	15	7.30	14.60	7.48	3.69	2.000	6.56	0.76	85.0		
128	1048	1038	8.60	72.0	33.5	91.0	80.0	30.00	59/64	6	18	3.72	12.80	6.56	2.15	3.442	3.82	0.95	62.0		

White Rose kerosene Sp. gr. = 0.801

129	1055	1042	83.00	92.0	32.0	87.5	80.5	29.95	1-18/64	Full	560	36.10	24.21	13.75	9.94	0.672	18.87	1.23	74.0	Regular tests following runs on Asiatic fuels contain- ing 75 per cent crude oil
130	1049	1043	8.30	65.0	27.0	79.5	78.5	29.93	"	5-1/2	90	3.61	10.50	5.96	2.29	2.910	43.65	0.57	96.0	
131	1048	1040	21.60	71.0	29.0	88.0	83.0	29.93	"	6-1/2	90	9.36	12.40	7.04	5.03	1.325	9.57	0.76	81.0	
132	1052	1042	42.30	76.0	28.0	81.0	80.0	29.90	"	8	90	18.37	15.90	9.02	7.71	0.865	14.66	0.95	96.0	
133	1054	1045	61.60	91.7	32.5	88.0	80.8	29.85	"	11	100	26.81	19.70	11.17	9.08	0.735	17.25	0.85	74.0	
134	1052	1040	69.50	91.0	31.8	88.0	81.0	29.87	1-14/64	14	50	30.12	20.60	11.67	9.76	0.684	18.55	1.14	74.0	
135	1052	1042	45.00	79.0	27.0	77.0	77.0	29.86	1-12/64	9	50	19.53	15.80	8.96	8.24	0.809	15.67	0.95	100.0	
136	1052	1044	22.50	72.5	26.0	78.0	77.0	29.86	1- 7/64	7	50	9.79	12.40	7.04	5.26	1.266	10.00	0.76	96.0	
137	1052	1038	87.00	84.0	25.0	77.5	76.5	29.86	1-27/64	Full	50	37.62	28.80	16.34	8.72	0.765	16.58	1.33	96.0	

75% White Rose + 25% Socony Diesel fuel Sp. gr. = 0.807

148	1055	1042	83.50	78.0	24.5	75.7	75.0	29.87	1-16/64	Full	Full	330	36.25	25.32	14.26	9.61	0.699	18.21	1.23	96.0	Regular tests following runs on Socony group containing 50 per cent crude oil
149	1053	1039	87.00	78.0	24.8	74.5	72.0	29.84	1-26/64	"	"	33	37.66	28.80	16.21	8.78	0.765	16.65	1.33	87.0	
150	1050	1040	63.20	78.0	24.0	74.0	71.5	29.80	1-16/64	11-1/2	"	30	27.39	20.30	11.43	9.06	0.742	17.15	0.95	91.0	
151	1048	1038	43.00	72.0	23.8	73.0	71.5	29.80	"	8	"	30	18.60	16.00	9.01	7.81	0.860	14.80	0.95	95.0	
152	1048	1040	18.50	67.0	24.0	73.0	71.0	29.80	"	6	"	30	8.02	11.90	6.70	4.53	1.484	8.58	0.76	91.0	
153	1052	1044	8.70	63.0	24.0	73.0	71.4	29.79	"	5-1/2	"	15	3.78	10.60	5.97	2.40	2.800	4.55	1.14	95.0	
154	1054	1042	24.50	65.0	24.2	74.0	71.0	29.80	1-12/64	7	"	15	10.64	12.80	7.21	5.58	1.203	10.58	1.14	86.0	
155	1058	1048	48.00	67.0	23.8	73.0	71.0	29.80	1-5/64	11	"	15	20.96	17.00	9.57	8.28	0.811	15.70	0.94	91.0	
156	1057	1047	71.80	75.0	24.0	73.5	71.5	29.80	1-14/64	15	"	15	31.33	22.00	12.38	9.57	0.702	18.15	0.95	91.0	

50% White Rose + 50% Socony Diesel fuel Sp. gr. = 0.828

138	1046	1033	84.50	89.0	32.8	89.0	82.0	29.92	1-27/64	Full	Full	550	36.35	26.70	14.66	9.38	0.734	17.50	1.24	74.5	Regular tests following runs on White Rose
139	1053	1041	83.00	80.0	29.5	81.0	78.0	29.91	"	"	"	100	36.02	27.75	15.23	8.95	0.771	16.65	1.14	87.5	
140	1048	1035	63.30	82.0	30.5	84.0	80.0	29.93	"	10-1/2	"	100	27.30	22.35	12.26	8.42	0.819	15.67	1.24	84.0	
141	1050	1041	40.70	76.0	33.8	92.0	81.0	29.92	"	7-1/2	"	100	17.65	17.20	9.44	7.07	0.975	13.17	0.86	62.0	
142	1056	1047	22.30	70.0	31.0	86.5	79.5	29.93	"	6	"	80	9.73	13.00	7.13	5.16	1.335	9.62	0.85	88.0	
143	1050	1046	8.40	66.0	31.4	87.0	79.0	29.88	"	5	"	80	3.66	10.15	5.57	2.49	2.770	4.63	0.38	70.5	
144	1046	1037	68.50	84.0	33.0	90.0	80.0	29.85	1-22/64	15	"	30	29.61	23.80	13.06	8.58	0.803	16.00	0.86	65.0	
145	1048	1038	46.00	80.0	32.2	89.0	81.0	29.85	"	8	"	30	19.91	17.00	9.33	8.08	0.854	15.03	0.95	71.0	
146	1052	1043	23.00	72.0	32.0	87.0	81.0	29.84	1-17/64	6	"	40	10.09	12.10	6.64	6.88	1.210	10.66	0.85	77.5	
147	1050	1046	9.40	69.0	31.0	87.0	80.0	29.85	1-11/64	6	"	30	4.10	10.20	5.60	2.77	2.488	5.16	0.38	74.0	

TABLE 3—Continued

TEST NO.	AVERAGE SPEEDS		DY- NAMETER LOAD	TEMPERATURES				BAR- OMETRIC PRES- SURE		INDEX READINGS		DURA- TION OF TESTS	DE- LIVER- ED HORSE- POWER	FUEL CONSUMPTION				BRAKE THER- MAL EFFI- CIEN- CY	BELT- SLIP- PAGE	RELA- TIVE HUMI- DITY	REMARKS
	En- gine	meter		Cool- ing water	Room	Dry bulb	Wet bulb	inches of mer- cury	Car- buretor	Throttle Ignition	lb. per hour			l. per hour	b.h.p. per gal.	lb. per b.h.p. hr.					
	r.p.m.	r.p.m.	lb.	°C.	°C.	°F.	°F.		notches	notches	notches	min- utes	b.h.p.					per cent	per cent		
Gasanol Sp. gr. = 0.779																					
41	1050	1042	85.50	98.0	36.0	95.0	79.0	29.90	1-35/64	Full	Full	570	37.20	31.44	18.35	7.67	0.845	19.56	0.76	49.5	
42	1040	1030	90.00	98.0	34.5	93.0	80.0	29.86	1-37/64	"	"	30	38.62	32.20	18.80	7.77	0.834	19.82	0.96	75.0	
43	1058	1050	7.70	72.0	31.8	90.0	79.6	29.94	1-35/64	5	"	120	3.37	14.22	8.30	1.53	4.220	3.92	0.76	62.0	
44	1052	1047	21.50	76.0	35.0	97.0	79.4	29.93	"	6	"	100	9.37	16.71	9.75	3.63	1.783	9.28	0.47	45.5	
45	1055	1047	42.80	82.0	32.3	91.0	78.0	29.91	"	8	"	100	18.69	21.30	12.42	5.68	1.140	14.50	0.76	56.5	
46	1051	1041	63.50	90.0	35.0	94.0	79.0	29.86	"	11-1/2	"	100	27.55	26.04	15.20	6.85	0.945	17.50	0.95	52.0	
47A	1051	1038	68.00	91.0	35.0	94.0	78.0	29.86	1-32/64	13	"	30	29.40	27.00	15.76	7.07	0.918	18.00	1.24	49.0	
47B	1051	1038	68.00	91.0	35.0	94.0	78.5	29.86	1-25/64	16	"	30	29.40	27.60	16.10	6.90	0.939	17.62	1.24	49.0	
48A	1055	1046	46.00	91.0	35.0	94.0	80.0	29.86	1-20/64	12	"	10	20.04	24.00	14.00	5.41	1.196	13.83	0.85	54.0	
48B	1058	1044	46.50	88.0	35.0	95.0	79.5	29.86	1-27/64	11	"	15	20.21	22.80	13.30	5.74	1.128	14.65	0.85	50.5	
48C	1050	1042	46.50	88.0	35.0	95.4	80.0	29.86	1-29/64	9	"	20	20.02	22.00	12.83	5.96	1.089	15.19	0.76	53.0	
48D	1042	1032	23.50	85.0	35.0	94.0	78.5	29.86	1-26/64	7	"	12	10.11	17.00	9.92	3.85	1.681	9.84	0.96	50.0	
48E	1041	1035	21.30	85.0	35.0	94.0	78.5	29.86	1-36/64	6	"	12	9.18	16.00	9.69	3.59	1.808	9.15	0.58	49.0	
90	1052	1038	83.00	84.0	26.8	80.0	78.5	29.84	1-29/64	Full	"	30	35.90	30.00	17.50	7.75	0.885	19.80	1.33	96.0	Special tests
92	1047	1036	62.50	81.0	27.0	79.5	77.5	29.84	"	12	"	21	26.96	25.40	14.83	6.87	0.943	17.56	1.05	91.0	after more
93	1048	1038	41.60	76.0	27.0	82.5	78.5	29.84	"	8	"	18	18.00	20.20	11.79	5.78	1.122	14.74	0.95	88.0	than 100 hours
94	1043	1035	21.80	74.0	27.8	82.0	78.0	29.86	"	6	"	18	9.40	16.00	9.33	3.80	1.702	9.72	0.77	84.0	of operation
95	1043	1036	7.60	70.5	28.3	83.0	78.5	29.86	"	5	"	18	3.28	13.12	7.65	1.62	3.997	4.14	0.67	83.5	
96	1050	1041	90.80	85.8	27.5	80.5	79.5	29.85	1-34/64	Full	"	15	39.39	32.20	18.80	7.92	0.818	20.20	0.86	96.0	
97	1050	1038	80.50	86.0	27.0	80.0	79.0	29.85	1-30/64	"	"	15	34.85	29.40	17.16	7.68	0.844	19.60	1.19	96.0	Tests to show
98	1055	1042	44.40	77.0	26.0	78.0	76.5	29.92	"	9	"	30	19.27	20.88	12.21	5.97	1.084	15.26	1.23	96.0	effect of full
99A	1054	1044	65.50	83.0	27.0	79.0	77.0	29.92	"	14	"	30	28.48	26.40	15.40	6.98	0.927	17.85	0.95	96.0	pre-heating
99B	1049	1040	23.10	70.0	28.0	81.0	78.5	29.92	"	6-1/2	"	18	10.01	15.60	9.10	4.16	1.558	10.62	0.86	91.5	

Regular tests
following
runs on Asiatic
group with 50
per cent crude
oil

Special tests
after more
than 100 hours
of operation

Tests to show
effect of full
pre-heating

Gastarla Sp. gr. = 0.786

	1052	1045	85.30	93.5	35.2	92.0	80.0	29.91	1-36/64	Full	Full	540	37.15	31.68	18.32	7.66	0.853	19.98	0.66	72.0
58A																				
58B	1051	1038	87.50	96.0	36.0	94.0	79.0	29.94	1-39/64	"	"	30	37.85	31.98	18.48	7.74	0.845	20.18	1.24	52.0
58C	1045	1035	84.00	94.0	36.0	93.0	79.0	29.93	1-35/64	"	"	30	36.20	31.20	18.05	7.58	0.862	19.77	0.96	54.0
59	1050	1043	6.20	68.5	31.0	86.5	78.0	30.03	1-36/64	5	"	100	2.69	13.80	7.98	1.27	5.126	3.33	0.67	70.0
60	1052	1044	22.20	74.0	32.5	90.0	79.0	30.03	"	6-1/2	"	100	9.66	17.43	10.08	3.63	1.805	9.44	0.76	62.0
61	1049	1040	42.50	80.0	33.5	89.0	87.0	30.01	"	8	"	100	18.40	21.90	12.67	5.49	1.190	14.31	0.86	58.5
62A	1052	1040	62.50	86.0	34.0	88.5	79.5	29.99	"	12	"	120	27.10	26.04	15.06	6.80	0.961	17.74	1.14	67.0
62B	1058	1044	68.00	85.5	33.0	90.0	80.0	29.96	1-32/64	14	"	33	29.58	27.60	15.95	7.01	0.938	18.27	1.32	65.0
62C	1040	1030	68.20	87.0	32.5	88.0	78.0	29.96	1-35/64	13	"	15	29.25	27.20	15.72	7.03	0.930	18.32	0.95	64.0
63A	1048	1040	45.20	82.0	33.0	90.0	79.0	29.95	1-27/64	11	"	20	19.58	22.80	13.18	5.62	1.163	14.65	0.76	62.0
63B	1044	1036	45.20	80.0	32.5	88.0	78.0	29.96	1-28/64	10	"	15	19.50	22.20	12.84	5.74	1.138	14.97	0.77	64.0
64A	1044	1038	23.00	79.5	32.2	86.0	78.0	29.96	1-21/64	8	"	15	9.94	17.70	10.23	3.67	1.782	9.56	0.57	70.0
64B	1041	1041	22.00	76.0	32.0	86.0	78.0	29.96	1-24/64	7	"	15	9.54	17.00	9.84	3.67	1.782	9.56	0.67	70.0
65	1045	1040	10.90	73.0	31.5	86.0	77.0	29.97	1-23/64	6	"	21	4.72	14.50	8.39	2.13	3.070	5.55	0.48	60.0
105	1055	1038	82.70	87.5	34.0	92.5	78.5	29.89	1-29/64	Full	"	24	35.78	32.60	18.84	7.18	0.911	18.70	1.61	54.0
106	1050	1036	63.20	85.0	35.0	93.5	82.0	29.90	"	12	"	24	27.30	25.60	14.81	6.97	0.938	18.15	1.33	60.0
107	1047	1036	42.50	83.0	34.0	93.0	78.0	29.90	"	8	"	24	18.35	20.60	11.91	5.82	1.122	15.18	1.05	51.5
108	1050	1040	19.80	76.0	33.8	93.0	79.0	29.86	"	6	"	27	8.58	15.80	9.14	3.55	1.842	9.25	0.95	54.0
109	1048	1040	7.60	72.0	33.5	91.0	80.0	29.86	"	5	"	18	3.29	11.20	6.48	1.92	3.400	5.01	0.76	62.0
110	1045	1039	8.00	72.0	33.0	89.5	76.5	29.85	"	5	"	18	3.46	13.00	7.52	1.74	3.752	4.54	0.57	56.0
111	1050	1040	25.10	72.0	33.0	89.5	76.5	29.85	"	6-1/2	"	15	10.87	16.80	9.72	4.23	1.545	11.03	0.95	56.0
112	1057	1045	42.50	82.0	33.5	89.5	78.5	29.86	"	8	"	21	18.50	20.50	11.92	5.90	1.109	15.36	1.13	62.0
113	1050	1041	60.00	83.5	32.5	88.5	78.5	29.84	"	12	"	18	26.03	25.20	14.64	6.78	0.965	17.65	0.86	64.5
114	1058	1045	78.00	89.0	33.0	88.0	78.0	29.85	"	Full	"	18	33.98	29.00	16.77	7.66	0.854	19.95	1.23	64.0
115	1048	1035	43.60	82.0	32.0	87.0	78.0	29.86	"	8-1/2	"	18	18.80	20.60	11.91	5.97	1.096	15.54	1.24	67.0
116	1051	1040	21.11	76.0	31.0	87.0	78.0	29.87	"	6	"	15	9.14	15.60	9.02	3.83	1.075	9.99	0.86	67.0
117	1053	1040	60.50	80.0	30.3	87.0	78.0	29.87	"	12	"	15	26.21	24.80	14.34	6.91	0.946	18.00	1.23	67.0
118	1049	1035	79.50	85.5	28.0	83.0	78.0	29.87	"	Full	"	15	34.30	29.20	16.88	7.63	0.851	20.00	1.33	80.0

Regular tests
following runs
on Gross PowerSpecial tests
after 100
hours of
operationSpecial tests
showing effect
of full
pre-heatingSpecial tests
showing effect
of medium
pre-heating

TABLE 4
Fuel consumption and relative increases at fractional loads

NAME OF FUEL	FULL LOAD		THREE-FOURTHS LOAD		ONE-HALF LOAD		ONE-FOURTH LOAD	
	lb./b.h.p.-hr.	Relative increase	lb./b.h.p.-hr.	Relative increase	lb./b.h.p.-hr.	Relative increase	lb./b.h.p.-hr.	Relative increase
Kizal	0.692	1	0.759	1.096	0.912	1.317	1.409	2.034
Cross Power	0.668	1	0.745	1.114	0.920	1.374	1.418	2.118
75% Cross Power + 25% Shell Diesel	0.679	1	0.746	1.099	0.904	1.328	1.417	2.060
50% " + 50% "	0.707	1	0.791	1.118	0.963	1.361	1.512	2.139
25% " + 75% "	—	—	1.084	—	1.268	—	2.202	—
White Rose	0.675	1	0.732	1.082	0.874	1.294	1.355	2.005
75% White Rose + 25% Socony Diesel	0.700	1	0.746	1.065	0.874	1.247	1.355	1.935
50% " + 50% "	0.739	1	0.822	1.112	0.965	1.305	1.390	1.881
Gasanol	0.835	1	0.945	1.131	1.120	1.336	1.746	2.090
Gasanol with full heat on	—	—	0.945	—	1.116	—	1.670	—
Gastarla	0.861	1	0.951	1.103	1.139	1.321	1.779	2.065
Gastarla with ½ heat on	—	—	0.935	—	1.121	—	1.710	—
Gastarla with full heat on	—	—	0.947	—	1.129	—	1.750	—

TABLE 5
Equivalent amount of fuel used in terms of the consumption of pure kerosene

NAME OF FUEL		FULL LOAD	THREE-FOURTHS LOAD	ONE-HALF LOAD	ONE-FOURTH LOAD
Cross Power		1.000	1.000	1.000	1.000
75% Cross Power + 25% Shell Diesel		1.015	1.001	0.984	1.000
50% " " + 50% " "		1.058	1.061	1.046	1.068
25% " " + 75% " "		— —	1.454	1.377	1.552
White Rose		1.000	1.000	1.000	1.000
75% White Rose + 25% Socony Diesel		1.036	1.018	1.000	1.000
50% " " + 50% " "		1.038	1.122	1.101	1.024
Gasanol		1.250 — 1.236	1.269 — 1.291	1.218 — 1.283	1.231 — 1.289
Gasanol with full heat on		— —	1.269 — 1.291	1.214 — 1.276	1.179 — 1.231
Gastarla		1.288 — 1.275	1.277 — 1.300	1.238 — 1.302	1.252 — 1.311
Gastarla with medium pre-heating on		— — —	1.255 — 1.278	1.219 — 1.281	1.208 — 1.261
Gastarla with full pre-heating on		— — —	1.272 — 1.294	1.228 — 1.292	1.235 — 1.292

TABLE 6
Weight of piston rings wear

NAME OF FUEL	RING 1 (CLOSEST TO PISTON HEAD)	RING 2	RING 3	RING 4 (CLOSEST TO CRANK END, FOR OIL)	TOTAL	PERIOD OF TEST
	grams	grams	grams	grams	grams	hours
Rizal						
Cross Power	0.0402	0.0305	0.0290	0.0904	0.1901	20.0
75% Cross Power + 25% Shell Diesel	0.0227	0.0078	0.0036	0.0119	0.0460	20.0
50% " + 50% "	0.0448	0.0103	0.0055	0.0154	0.0760	20.0
25% " + 75% "	0.0302	0.0061	0.0053	0.0084	0.0505	14.5
White Rose	0.0435	0.0375	0.0299	0.0233	0.1342	20.0
75% White Rose + 25% Socony Diesel	0.0144	0.0047	0.0036	0.0014	0.0241	9.0
50% " + 50% "	0.0417	0.0136	0.0206	0.0153	0.0912	20.0
Gasanol	0.0148	0.0134	0.0153	0.0304	0.0739	20.0
Gastarla	0.0131	0.0075	0.0058	0.0057	0.0321	20.0
Miscellaneous tests	0.0275	0.0070	0.0064	0.0073	0.0482	15.0
Total	0.2929	0.1381	0.1255	0.2095	0.7663	178.5
Percentage	38.2	18.1	16.4	27.3	100	

TABLE 7
Relative wear of engine using different mixtures at various periods of engine life

PER CENT DIESEL FUEL IN CROSS POWER KEROSENE	HOURS															
	40		60		80		100		120		140		160		180	
	Wear	Relative increase	Wear <i>grams</i>	Relative increase	Wear <i>grams</i>	Relative increase	Wear <i>grams</i>	Relative increase	Wear <i>grams</i>	Relative increase	Wear <i>grams</i>	Relative increase	Wear <i>grams</i>	Relative increase	Wear <i>grams</i>	Relative increase
0	0.0960	1.000	0.0675	1.000	0.0515	1.000	0.0425	1.000	0.0375	1.000	0.0350	1.000	0.0330	1.000	0.0317	1.000
25	0.0990	1.031	0.0710	1.051	0.0555	1.077	0.0460	1.082	0.0415	1.105	0.0385	1.100	0.0363	1.100	0.0350	1.104
50	0.1040	1.083	0.0755	1.118	0.0593	1.150	0.0505	1.187	0.0455	1.212	0.0425	1.213	0.0405	1.227	0.0395	1.245
75	0.1105	1.151	0.0820	1.214	0.0660	1.282	0.0570	1.340	0.0520	1.385	0.0495	1.414	0.0470	1.424	0.0460	1.450

TABLE 8
Weight of carbon deposit per cylinder

NAME OF FUEL	PISTON			CYLINDER		SPARK PLUG	TOTAL	PERIOD OF TEST
	Wall and ring grooves	Rings	Head	Wall	Head			
Rizal	grams	grams	grams	grams	grams	grams	grams	hours
Cross Power	0.3296	0.1166	0.6899	0.4507	2.4237	trace	4.0105	20.0
75% Cross Power + 25% Shell Diesel	0.5230	0.0454	1.3894	0.4061	2.8220	trace	5.1859	20.0
50% " " + 50% " "	0.7609	0.0448	1.2810	1.4590	2.9856	0.0554	6.5867	20.0
25% " " + 75% " "	1.1898	0.1135	2.3764	1.6210	7.0343	0.0895	12.4245	20.0
White Rose	0.4088	0.0096	2.6763	0.9190	5.0523	0.2292	9.2952	14.5
75% White Rose + 25% Socony Diesel	0.7469	0.0901	1.1246	0.5222	1.9942	0.0348	4.5128	20.0
50% " " + 50% " "	0.3382	0.0055	1.3315	0.6515	4.0895	0.0018	6.4180	9.0
Gasanol	1.4197	0.4533	2.2185	1.1845	6.2026	0.1934	11.6720	20.0
Gastarla	0.1434	trace	2.4954	0.7037	2.3930	trace	5.7355	20.0
	0.0731	trace	2.4157	0.6705	3.4635	trace	6.6223	20.0
Total	5.9334	0.8788	17.9987	8.5882	38.4607	0.6041	72.4639	183.5
Percentage	8.2	1.2	24.9	11.9	53.0	0.8	100	—

TABLE 9
Dilution, viscosity, and consumption of lubricating oil

NAME OF FUEL	PERIOD OF TEST	USED OIL				CONSUMPTION			VISCOSITY AFTER	
		Specific gravity after		Dilution after		Temper- ature after 10 hours	Volume of new oil	Volume of used oil	Rate of consump- tion after 20 hours	
		10 hours	20 hours	10 hours	20 hours				cc.	poises
Rizal	hours	at 26° C.	at 26° C.	per cent	per cent	° C.	cc.	cc.	cc.	poises
Cross Power	20.0	0.9020	0.8950	25.0	33.1	77.7	10,750	15,060	675	0.50
75% Cross Power + 25% Shell Diesel	20.0	0.9210	0.9180	16.0	19.0	80.0	10,500	10,835	1,724	1.31
50% " + 50% "	20.0	0.9295	0.9225	18.6	22.5	77.0	10,500	12,660	689	0.64
25% " + 75% "	20.0	0.9235	0.9185	15.6	26.2	77.5	10,500	16,000	....	1.23
"	10.0	0.8982	.....	70.0	....	69.5	10,500	33,810 ^a	357 ^a	0.70
White Rose	4.5	0.9100	.....	35.4 ^b	....	....	8,000	15,350 ^b	684 ^b	0.12
75% White Rose + 25% Socony Diesel	20.0	0.9233	0.9200	11.9	15.0	77.0	10,500	9,300	2,595	0.32
50% " + 50% "	6.0	0.9170	.....	18.5 ^c	....	77.0	10,500	10,000 ^c	2,350 ^c	1.59
Gasanol	20.0	0.9070	0.9020	29.0	38.5	68.0	10,500	15,900	722	1.21
Gastarla	20.0	0.9330	0.9330	2.3	2.8	82.0	10,500	8,450	2,287	....
	20.0	0.9330	0.9330	2.8	3.2	83.0	10,500	8,200	2,562	0.58
									4.51	3.49
									4.17	4.74

New oil has sp. gr. = 0.9331 and viscosity = 5.30

^a After 10 hours of operation.

^b After 4½ hours of operation.

^c After 6 hours of operation.

TABLE 10
Summary table including relative fuel costs

NAME OF FUEL	SPECIFIC GRAVITY	TOTAL WEIGHT OF CARBON	TOTAL RING WEAR	DILUTION AFTER		VISCOSITY AFTER		CONSUMPTION OF FUEL	
				10 hours	20 hours	10 hours	20 hours	At full load	At half load
Rizal	0.817	grams	grams	per cent	per cent	poises	poises	lb./b.h.p.-hr.	lb./b.h.p.-hr.
Cross Power	0.846	4.0105	—	25.0	33.1	0.50	0.32	0.692	0.912
75% Cross Power + 25% Shell Diesel	0.871	5.1859	0.1901	16.0	19.0	1.31	0.64	0.668	0.920
50% " " + 50% " "	0.875	6.5867	0.0460	18.6	22.5	1.23	0.58	0.679	0.904
25% " " + 75% " "	0.887	12.4245	0.0760	15.6	26.2	0.70	0.43	0.707	0.963
White Rose	0.801	9.2952	0.0505	70.0-35.4 ^a	—	—	—	—	1.268
75% White Rose + 25% Socony Diesel	0.807	4.5128	0.1342	11.9	15.0	1.59	1.23	0.675	0.874
50% " " + 50% " "	0.828	6.4180	0.0241	18.5 ^b	—	—	—	0.700	0.874
Gasanol	0.779	11.6720	0.0912	29.0	38.5	0.58	0.46	0.739	0.965
Gastarla	0.786	5.7355	0.0739	2.3	2.8	4.51	3.49	0.835	1.120
		6.6228	0.0321	2.8	3.2	4.17	4.74	0.861	1.139

^a After 4-1/2 hours.

^b After 6 hours.

TABLE 10—Continued

NAME OF FUEL	BRAKE THERMAL EFFICIENCY AT		EQUIVALENT AMOUNT OF FUEL USED IN TERMS OF THE MOST ECONOMICAL KEROSENE				FACTOR BY WHICH TO MULTIPLY THE COST OF ONE VOLUME OF THE MOST ECONOMICAL PURE KEROSENE (BY WEIGHT) TO OBTAIN THE EQUIVALENT COST OF THE SAME VOLUME OF OTHER FUELS	
	Full load	Half load	Full load	Half load	Full load	Half load	Full load	Half load
Rizal	<i>per cent</i>	<i>per cent</i>	<i>by wt.</i>	<i>by vol.</i>	<i>by wt.</i>	<i>by vol.</i>		
Cross Power	18.48	14.02	1.033	1.070	1.043	1.022	0.934	0.974
75% Cross Power + 25% Shell Diesel	19.35	14.08	1.000	1.000	1.052	0.996	1.000	1.000
50% " " + 50% " "	18.50	14.46	1.015	0.986	1.034	0.947	1.015	1.051
25% " " + 75% " "	18.61	13.64	1.058	1.012	1.102	0.993	0.987	1.003
White Rose	—	9.96	—	—	1.450	1.310	—	0.760
75% White Rose + 25% Socony Diesel	18.85	14.52	1.009	1.065	1.000	1.000	0.939	0.996
50% " " + 50% " "	18.21	14.57	1.047	1.097	1.000	0.992	0.912	1.004
Gasanol	17.38	13.31	1.106	1.130	1.105	1.070	0.885	0.930
Castrola	19.85	14.80	1.250	1.358	1.282	1.319	0.737	0.755
Castrola	19.28	14.96	1.288	1.387	1.302	1.328	0.721	0.750

AN INTERESTING REACTION OF A SUGAR CANE VARIETY TO GRASS MOSAIC ¹

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WITH TWO TEXT FIGURES

On January 2, 1932 a stalk of sugar cane (*Saccharum officinarum* L.) variety Linabnig was sent to the writer by Mr. Toribio Mercado of the Plant Breeding Division, Department of Agronomy of the College of Agriculture at Los Baños. The main stalk of the sugar cane showed very conspicuous mottling symptoms of grass mosaic in its leaves. Cankered areas were present on the stalk. The stalk had been cut as close to the ground level as possible. From nodes, 4, 5, 6 and 7, numbering from the lower end of the plant upwards, there were well developed lateral shoots. The diameter of the branches was only slightly shorter than that of the main stem. The internodes, however, were very short. They varied from one to three centimeters in length. The shoots were free from the mottling of the leaves and the canker of the stems. On account of the rather advanced stage of the disease the leaves of the main stem were much paler than those of the lateral shoots. The paleness was due to the fact that the mottling was more or less diffuse. The leaves of the main stem and lateral shoots were removed, and to prevent wilting the base was placed in a jar of water. For convenience in handling, the shoots were given the number of the nodes on which they were borne.

On January 8, 1932 lateral shoots numbers 4, 5, 6, and 7 were cut off as near the point of attachment as possible. The main stalk was cut into five parts and these were labeled A, B, C, D, and E; the basal cutting was numbered A and the apical cutting, E. The cuttings were tied together in a bundle and immersed in tap water for 48 hours. After immersion in water they were wrapped with wet cheese cloth to germinate.

On January 18, 1932 the cuttings were planted in sterilized garden soil in pots and kerosene cans cut in halves. Notes on the emergence of the shoots were taken. The dates of emergence and appearance of the mottling of the leaves are given in table 1.

¹ Experiment Station contribution No. 839. Received for publication June 16, 1932.

TABLE 1

Dates of emergence of the shoots from the cuttings of the main stalk and lateral shoots and appearance of the mottling on the leaves

PORTION OF MAIN STALK AND LATERAL SHOOTS	DATE OF EMERGENCE OF SHOOTS	DATE OF APPEARANCE OF MOT- TLING ON LEAVES
<i>Main stalk</i>		
A	Did not emerge	
B	January 25, 1932	February 4, 1932
C	February 1, 1932	February 8, 1932
D	January 25, 1932	February 4, 1932
E	January 25, 1932	February 4, 1932
<i>Lateral shoots</i>		
4A ^a	February 3, 1932	
4B	January 25, 1932	
5	January 28, 1932	
6	January 25, 1932	
7	January 25, 1932	

^a Lateral shoot No. 4 was cut into two on account of its length.

In addition to being free from mosaic symptoms on the leaves the plants from the apparently healthy lateral shoots (4A, 4B, 5, 6



Fig. 1.—A photograph of the plants from cuttings A, B, C, D and E obtained from the main stalk which had conspicuous mottling of the leaves, compared with the plants from the main shoots 4A, 4B, 5, 6 and 7. The difference in color is not shown by the photograph. Cutting A from the main stalk did not germinate. Note the relative size of the plants and the stools produced. (Photographed April 3, 1932 by Photographic Division, Department of Soils).

and 7) were larger and taller than the shoots from the main stalk (B, C, D and E) as shown in the photograph (fig. 1) taken on April 3, 1932. This relative size of the shoots was very conspicuous on June 9, 1932. Not only was there a conspicuous difference in size of the stalks and color of the leaves but the plants from the lateral shoots had a better tillering habit. Leaves of corresponding age and position on plants with and without mottling were also photographed on April 3, 1932. Although the photograph does not show the mottling, the difference in size between the leaves without mot-

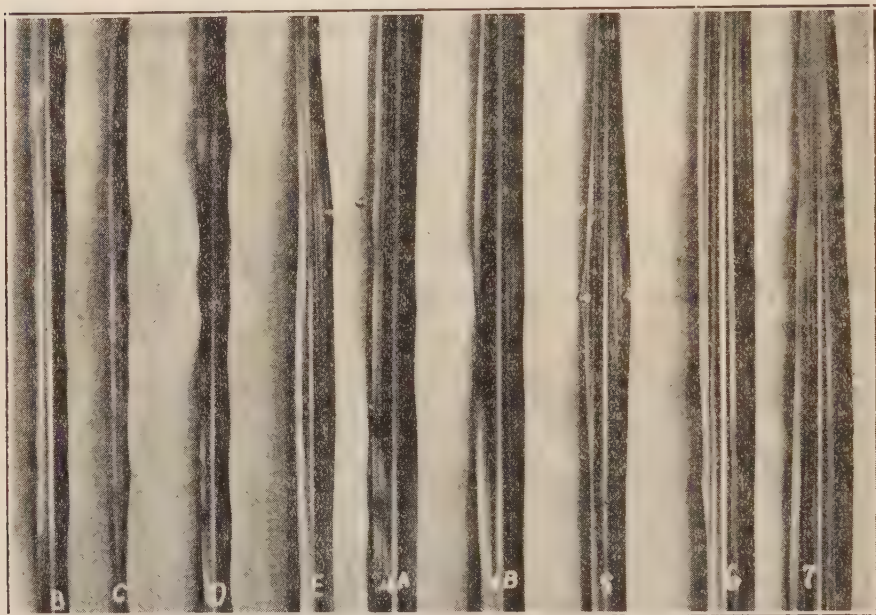


Fig. 2.—Leaves of corresponding age and position in the plants photographed to show the difference in width. Leaves B, C, D and E were taken from plants with mottled leaves and 4A, 4B, 5, 6 and 7 from plants with clean leaves. (Photographed April 3, 1932 by Photographic Division, Department of Soils.)

tling (4A, 4B, 5, 6 and 7) and those that were mottled (B, C, D, E) may be noted in figure 2. The shoots which did not exhibit mottling in the leaves had better stooling characteristics and produced stalks and leaves larger than the plants with mottling. In size of the stalks and stooling habit the stalks without mottling on the leaves seem to be similar in nature to the mosaic-tolerant canes described by Edgerton and Taggart (1924).

On March 5, 1932 the canes were fertilized by applying a solution of 10 grams of ammonium sulfate around each potted plant,

A fertilizer was applied to induce growth and tillering. Although the stalks that showed symptoms on the leaves grew fast because of the fertilizer, nevertheless they did not develop as luxuriantly as the stalks from the lateral shoots that were free from mottling of the leaves.

The production by the Linabnig cane of side branches with leaves free from mosaic symptoms was first believed to be behavior toward the mosaic disease similar to that described by Stahl and Faris (1929) in Cuba. These authors found that in resistant varieties like the POJ canes mosaic is not distributed throughout the whole stalk. These authors further reported that the healthy plants obtained from healthy eyes of mosaiced stalks remain healthy through the first ratoon and that seed pieces cut from these plants produce healthy plants. To determine whether the plants from the lateral shoots of Linabnig are free from the grass mosaic virus or not an experiment to transmit the disease following the mechanical method for artificially transmitting sugar-cane mosaic which was described by Miss Wilbrink (1929) in Java and by Sein (1930) in Porto Rico, was performed by Mr. Evaristo Hurtado under the writer's direction. Young healthy shoots from cuttings of Mauritius 1900 were inoculated under controlled conditions. Stalks from lateral shoots No. 4A, No. 4B, and stalk 1 of No. 5 were used as source of inoculum. The result of the transmission experiment is given in table 2.

TABLE 2

The result of mechanical transmission from apparently mosaic-free Linabnig cane shoots to shoots of Mauritius 1900

DATE OF INOCULATION	SOURCE OF INOCULUM	NUMBER OF SHOOTS INOCULATED	NUMBER OF SHOOTS INFECTED	DATE OF APPEARANCE OF MOTTLING ON LEAVES OF INOCULATED SEEDLINGS
April 11, 1932	Lateral shoot 4A	9	6	From April 16, 1932 to May 4, 1932
April 14, 1932	Lateral shoot 4B	5	3	From May 4, 1932 to May 16, 1932
April 14, 1932	Lateral shoot 5 stalk 1	3	1	April 22, 1932
April 19, 1932	" "	5	3	From May 14, 1932 to May 16, 1932

In table 2 it may be seen that although the source of inoculum did not show symptoms of mosaic a high percentage of infection resulted when the virus was transferred mechanically to healthy Mauritius 1900 canes. This result shows that the canes from the lateral shoots of Linabnig had the grass mosaic virus in them like the main stem, but on account of some characteristics which are not well understood the mottling symptoms did not appear.

On June 9, 1932 the final examination for mosaic symptoms was made on the leaves and stalks of the lateral shoots of Libnabnig. Anticipating an interesting result, if not a practical application from this reaction of Linabnig to the grass mosaic, the stalks which did not exhibit symptoms of the disease were cut as close to the ground as possible for propagation purposes. The mosaic disease is very widely distributed among native cane varieties and some of the introduced canes. On account of this wide distribution of the grass mosaic much hope is in store for the progeny of this cane being a valuable material to use in our attempt to reduce the status of the mosaic disease to a minor nuisance. As all of the plants contain the mosaic virus no effort was made to sterilize the knife used for cutting the stalks. The result of the final examination for the presence of mottling on the leaves is given in table 3.

TABLE 3

The number of stalks produced by each lateral shoot and the condition of each stalk in regard to grass mosaic

LATERAL SHOOT NUMBER	STALKS		
	Total number	Without mottling on leaves	Doubtful or damaged
4A	6	2, 3 and 4	1 and 5
4B	5	3	1, 2, 4 and 5
5	8	1, 4 and 5	2, 3, 6, 7 and 8
6	3	1, 2 and 3	0
7	7	5	1, 2, 3, 4, 6 and 7

In table 3 it may be seen that only the stalks from lateral shoot No. 6 were entirely free from mottling in the leaves. For purposes of multiplication and further selection only the stalks free from mottling on the leaves were taken and all of those that showed mosaic symptoms were discarded.

On October 11, 1932 when this paper was in galley proof the plants in the experimental plot were inspected for the appearance of

mosaic symptoms. The result of this inspection showed that of the total of 29 stools the following had mottling in the leaves:

- 1 of 4 stalks from seed-piece 4A-2c.
- 1 of 4 stalks from seed-piece 6-1b.
- 2 of 6 stalks from seed-piece 6-3a.
- 1 of 6 stalks from seed-piece 6-3b.

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TO WHAT EXTENT CAN HEAD MEASUREMENTS OF HENS BE USED IN SELECTION ¹

F. M. FRONDA AND ACELO C. BADELLES²

WITH FOUR TEXT FIGURES

One of the important problems that a poultry raiser encounters in the course of his operations is the detection and elimination of the low producing birds from his flock. Knowledge about certain physical characters that are related to the producing ability in poultry is rapidly increasing. The importance of the application of this knowledge in the culling of unproductive fowls for the market, thus enabling the poultryman to retain only the most profitable birds for commercial production, make such a study as the one here given of value and necessity.

In a previous paper on this subject, Fronda and Gamo (1930)³ reported that certain head characters of Cantonese pullets and hens may be used as a guide in the selection of fowls for egg production. Some of the characters that they found to have significant correlation with egg production were:

(1) Distance from the base of comb to the top of eye. The shorter the distance, the better the hen or pullet as a layer.

(2) Distance from the top of the eye to the nostril. The greater this distance, the poorer the hen as an egg producer.

(3) Distance from the base of the comb to the base of the wattle. The greater this distance, the greater the tendency of the hen for heavy production.

(4) The width of the beak may be used in the selection of a good layer. The wider the beak, the better the hen or pullet as a layer.

(5) Distance from the base of the comb to the rear of the eye. The shorter this distance, the better the hen as an egg producer.

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² Doctor Fronda is a member of the staff of the Department of Animal Husbandry, in charge of poultry.

Mr. Badelles is of Class 1932, College of Agriculture. To him belongs the credit of having made the measurements presented in this paper.

³ FRONDA, F. M., AND F. S. GAMO. 1931. The relation of some head characters and egg production among Cantonese fowls. *THE PHILIPPINE AGRICULTURIST* 20: 261-268.

(6) The size of the space in the socket in front of the eyeball. The wider this space the better the hen or pullet as a layer.

To a poultryman, answers to the following questions should be of interest: To what extent can actual head measurements be used in actual selection? What norm of measurements of the head characters that were reported by Fronda and Gamo (1930) to be correlated with egg production among Cantonese hens may be used?

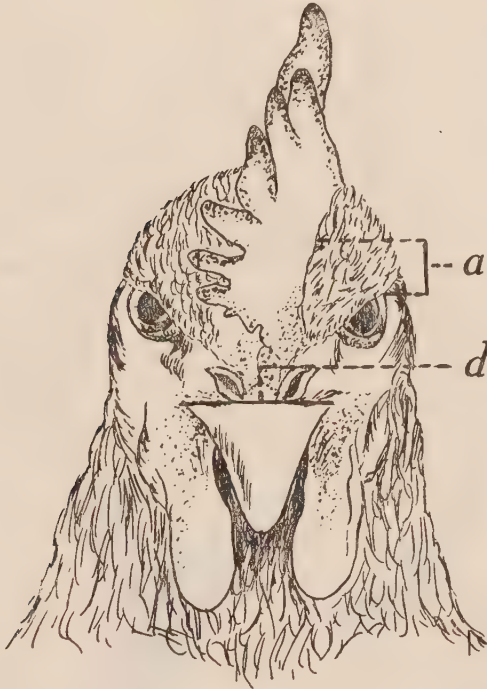


Fig. 1.—Front view of the head of a Cantonese hen showing the measurements made with the chicken's head turned towards the operator. (*a*) Distance from the base of the comb to the top of the eye. (*d*) Width of the beak.

A flock of 95 yearling Cantonese hens were used in the present study. Measurements of the head characters that were reported by Fronda and Gamo (1930) to be correlated with egg production were made. The means and probable errors of these measurements were determined. The individual records of egg production of these birds were obtained and classified according to the measurements made.

CHARACTERS STUDIED

In making the measurements, the procedure used by Fronda and Gamo (1930) was strictly followed. The characters and procedure were described by them as follows:

1. *Distance from the base of the comb to the top of the eye.* Before measuring the shortest distance from the base of the comb to the top of the eye, the standing feathers on the top surface of the skull were moistened so they would lie close to the skull, thus the base line could be seen distinctly. (See fig. 1a.)

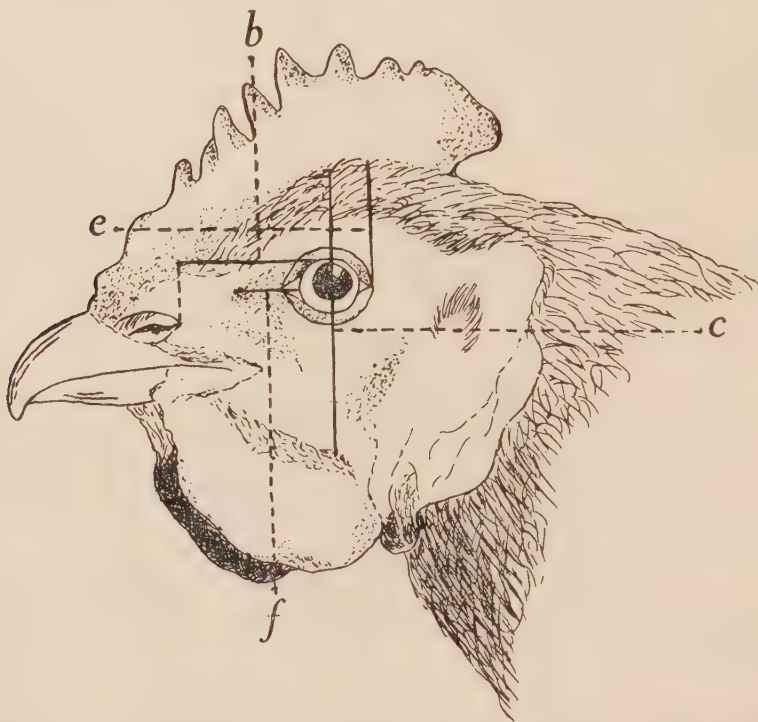


Fig. 2.—Side view of the head of a Cantonese hen showing the measurements made from the side. (b) Distance from the top of the eye to the nostril. (c) Distance from the base of the comb to the base of the wattle. (e) Distance from the base of the comb to the rear of the eye. (f) The size of the socket in front of the eyeball.

2. *Distance from the top of the eye to the nostril.* The horizontal distance was measured from the inner canthus of the eye to the back of the nostril. (See fig. 2b.)

3. *Distance from the base of the comb to the base of the wattle.* In measuring the depth of the head, the operator is likely to make

errors unless he has fixed points of measurements. This depth was measured with a ruler from the base of the wattle intersecting the eye at the middle. (See fig. 2c.)

4. *Width of the beak.* The width of the beak was obtained by the use of a caliper. When measuring, the chicken's head was turned towards the operator, with the caliper resting on his arm parallel to the bird's eyes. Then an equal pressure was applied on the handle of the caliper until both ends touched the base of the beak. (See fig. 1d.)

5. *Distance from the base of the comb to the rear of the eye.* With a ruler, the shortest distance was measured from the base of the comb to the outer canthus of the eye. (See fig. 2e.)

6. *The size of the space in the socket in front of the eyeball.* The size of the orbit towards the inner canthus was obtained by measuring the distance from a well marked tiny depression just in front of the eye. This character was accurately determined when the bird's eye was open. (See fig. 2f.)

RESULTS AND DISCUSSION

The results obtained in this study are shown in tables 1 to 6.

TABLE 1

Showing the distance from base of comb to top of eye

V	f	ANNUAL EGG PRODUCTION		
		Weighted average	Maximum	Minimum
.70	3	131	146	120
.75	7	125	155	104
.80	30	127	146	103
.85	13	120	166	100
.90	34	115	143	99
.95	—	—	—	—
1.00	6	111	131	88
1.05	—	—	—	—
1.10	2	108	114	102

$$M = 0.854 \pm 0.005$$

By reference to table 1 the distance between the base of the comb and the top of the eye may be seen. As shown in this table, a mean of 0.854 ± 0.005 cm. was obtained in the present study. Fronda and Gamo (1930) reported a mean of 0.856 ± 0.003 cm. The average between the two means which is 0.855 ± 0.006 cm. may be used as a norm in this particular head character among Cantonese fowls.

It is of interest to note that the result obtained in the present study is similar to that reported by Fronda and Gamo (1930), that is, the shorter the distance between the base of the comb and the top of the eye, the better producer the bird is likely to be.

In the present study, all birds in which the distance between the base of the comb and the top of the eye measured less than the mean, 0.854 cm., generally have greater average egg production than those birds in which the distance between these two points measured more than the mean. For instance, the birds having a measurement of 0.7 cm. have an average production of 131 eggs while those birds having a measurement of 1.1 cm. have a production of only 108 eggs.

It is apparent that the distance from the base of the comb to the top of the eye may be used as a guide in the selection of a good layer. Looking over the individual egg records of the birds it was found that there were 16 fairly good layers out of the 42 that were included with the discards, that is, birds in which the distance from the base of the comb to the top of the eye measured over 0.854 cm. The average production of the discards was 117 eggs. All the birds that had a production more than the average were considered fairly good layers. To be safe, so that average layers may not be included with those culled, it is recommended, among Cantonese hens, that a measurement of not more than 0.90 cm. should be used in the selection of a good layer. In other words, birds in which the distance from the base of the comb to the top of the eye measures over 0.90 cm. should be culled.

TABLE 2
Showing the distance from top of eye to nostril

V	f	ANNUAL EGG PRODUCTION		
		Weighted average.	Maximum	Minimum
1.30	8	139	166	120
1.35	3	133	146	121
1.40	13	129	155	110
1.45	8	121	148	103
1.50	25	118	143	99
1.55	7	113	144	101
1.60	23	112	128	88
1.65	6	108	124	100
1.70	2	102	102	102

$$M = 1.50 \pm 0.008$$

Table 2 shows the same relationship between the distance from the top of the eye to the nostril and egg production as in the fowls reported by Fronda and Gamo (1930). The mean obtained in this

particular head measurement is 1.50 ± 0.008 cm. Fronda and Gamo (1930) reported the mean of 1.424 ± 0.003 cm. for this character. The average between the two means is 1.462 ± 0.008 cm. This average mean may be used as a norm among Cantonese hens.

As shown in the same table, all birds in which the distance from the top of the eye to the nostril measured from 1.30 to 1.50 cm. have production that ranged from 118 to 139 eggs, while those birds in which the distance between these two points measure from 1.55 to 1.70 cm. have a production that ranged from 102 to 113 eggs. Likewise, this measurement of the head may be used as a guide in the selection of a good layer. The individual records show that there were 14 fairly good layers out of 38 that were included with the discards, that is, those birds in which the distance from the top of the eye to the nostril measured over 1.50 cm. The average production of the discards was 112 eggs. All the birds that had a production that was more than the average were considered fair layers. It is recommended, however, that a distance of not more than 1.55 cm. be used so that the chances of including such average layers with those that are culled, will be minimized.

TABLE 3
*Showing the distance from the base of comb to
base of wattle*

V	f	ANNUAL EGG PRODUCTION		
		Weighted average	Maximum	Minimum
3.40	5	98	104	88
3.45	4	105	114	100
3.50	12	105	111	101
3.55	8	109	118	103
3.60	9	113	123	108
3.65	7	116	128	100
3.70	14	125	166	115
3.75	8	128	132	118
3.80	11	124	148	119
3.85	7	130	145	110
3.90	3	133	137	129
3.95	4	145	147	143
4.00	1	146	146	146
4.05	2	139	155	119

$$M = 3.67 \pm 0.011$$

By reference to table 3, the distance from the base of the comb to the base of the wattle may be seen. A mean distance from the base of the comb to the base of the wattle of 3.67 ± 0.011 cm. was obtained in the present study. Fronda and Gamo (1930) reported

3.82 ± 0.013 cm. or an average of 3.75 ± 0.017 cm. between the two measurements. It will be seen also that the birds in which the distance from the base of the comb to the base of the wattle measured from 3.40 to 3.65 cm. had an average production that ranged from only 98 to 116 eggs, while those birds in which the distance between these points measured from 3.70 to 4.05 cm. had an average production that ranged from 124 to 146 eggs. These results show that the wider the distance, the better is the hen as a layer.

It is a matter of common knowledge among workers in poultry husbandry that the depth of the head has a marked correlation with the physical vigor and egg production of the bird. The individual records of the birds show that there were 26 fair layers out of 45 that were included with the discards, those birds in which the distance from the base of the comb to the base of the wattle measured below 3.67 cm. The average production of the discards was 106 eggs. If all the birds that had a production of more than the average were considered as fair layers, a distance of not less than 3.60 cm. is recommended as standard measurement of this particular character of the head, so that the inclusion of fairly good producers among the discards will be minimized.

TABLE 4
Showing the width of beak

V	f	ANNUAL EGG PRODUCTION		
		Weighted average	Maximum	Minimum
1.30	1	101	101	101
1.35	5	114	133	99
1.40	10	116	134	99
1.45	13	121	147	106
1.50	20	117	135	88
1.55	10	120	155	107
1.60	18	123	146	101
1.65	5	118	137	104
1.70	9	118	145	102
1.75	1	104	104	104
1.80	1	128	128	128
1.85	—	—	—	—
1.90	2	143	143	143

$$M = 1.53 \pm 0.014$$

The measurements of the width of the beak of Cantonese hens are given in table 4. The mean width of the beak obtained in this study was 1.53 ± 0.014 while Fronda and Gamo (1930) reported a mean width of 1.69 ± 0.004 ; the average of the two is 1.61 ± 0.015 cm.

This average mean may be used as a norm among Cantonese hens. The birds in which the width of the beak measured from 1.30 to 1.55 cm. had an average production that ranged from 101 to 121 eggs only, while the birds in which the width of the beak was 1.60 cm. to 1.90 cm. had an average production that ranged from 104 to 143 eggs.

These results show that although the relationship between the width of the beak and egg production is not very marked, there is a tendency that the wider the beak the greater the chance that the bird will be the better layer. But the individual records show that there were 25 fairly good layers that were included with the discards, those birds in which the width of the beak measured below 1.53 cm. The average production of these discards was 119 eggs. If all the birds that had a production of more than the average were considered as fair layers, to be safe from including these with the poor ones, it is recommended that the width of the beak to be used as a standard measurement be not less than 1.4 cm.

TABLE 5

Showing the distance from base of comb to rear of eye

V	f	ANNUAL EGG PRODUCTION		
		Weighted average	Maximum	Minimum
.80	5	131	155	113
.85	1	133	133	133
.90	3	129	146	120
.95	6	126	137	110
1.00	22	125	148	101
1.05	1	107	107	107
1.10	35	112	144	100
1.15	4	105	107	102
1.20	15	111	143	88
1.25	2	116	118	114
1.30	1	114	114	114

$$M = 1.60 \pm 0.008$$

Table 5 shows the distance from the base of the comb to the rear of the eye. In the present study a mean distance from the base of the comb to the rear of the eye of 1.06 ± 0.008 cm. was obtained. Fronda and Gamo (1930) reported that for Cantonese hens this distance measured 1.15 ± 0.005 cm. The average of the two observations is 1.10 ± 0.009 cm.

The birds in which the distance from the base of the comb to the rear of the eye measured from .80 cm. to 1.05 cm. had an average production that ranged from 107 to 133 eggs, while the birds in

which the distance between the two points measured from 1.10 cm. to 130 cm. had an average production that ranged from 105 to 116 eggs.

The individual egg records of the birds show that there were 26 fair layers out of the 58 that were included with the supposed discards, that is, those birds in which the distance from the base of the



Fig. 3.—Side view of the head of a Cantonese hen showing ideal measurements. Note the flat head, eye carried forward close to the nostril and the deep head.

comb to the rear of the eye measured over 1.05 cm. The average production of these discards was 114 eggs. If all the birds whose production was more than this average were considered fair layers, it is recommended to use not more than 1.20 cm. from the base of the comb to the rear of the eye as standard measurement in the selection of a good layer in order to prevent the error of including these birds with the culls.

By reference to table 6 the size of the space in the socket in front of the eyeball may be seen. The size of this socket was observed to be 0.99 ± 0.008 cm. in the present study; Fronda and Gamo (1930) reported a mean measurement of 0.994 ± 0.070 cm.; this gives an average of 0.967 ± 0.078 cm. between the two means.

The birds in which the size of the space in the socket in front of the eyeball measured from .70 to .95 cm. had an average production that ranged from 108 to 118 eggs only, while those birds in



Fig. 4.—Side view of the head of a Cantonese hen showing poor measurements. Note the long head, shallow eye far from the nostril and more or less rounded head.

which the size of the space in the socket in front of the eyeball measured from 1.00 to 1.25 cm. had an average production that ranged from 117 to 146 eggs. This result unmistakably shows that the larger the space in the socket in front of the eyeball the greater is the tendency of the bird to lay more eggs. The egg records of the birds show that there were 15 fairly good layers out of 26 that were included with the discards, the birds in which the size of the space in the socket measured below 0.99 cm. It is recommended that a

measurement of not less than 0.90 cm. be used as a standard measurement in the selection of a good layer based on the above head character so that chances of including average layers with the poor ones will be minimized.

TABLE 6
*Showing the size of space in the socket
in front of eyeball*

V	f	ANNUAL EGG PRODUCTION		
		Weighted average	Maximum	Minimum
.70	3	110	120	101
.75	—	—	—	—
.80	9	108	126	88
.85	2	114	114	114
.90	11	112	132	118
.95	1	118	118	118
1.00	37	117	148	101
1.05	4	124	155	107
1.10	18	125	147	107
1.15	1	124	124	124
1.20	8	123	166	108
1.25	1	146	146	146

$$M = 0.99 \pm 0.008$$

SUMMARY

1. The following measurements of the head characters studied may be used as a norm among Los Baños Cantonese hens:

- (a) For the distance from the base of the comb to the top of the eye, 0.855 ± 0.006 cm.
- (b) For the distance from the top of the eye to the nostril, 1.462 ± 0.008 cm.
- (c) For the distance from the base of the comb to the base of the wattle, 3.75 ± 0.017 cm.
- (d) For the distance from the base of the comb to the rear of the eye, 1.10 ± 0.009 cm.
- (e) For the width of the beak, 1.61 ± 0.015 cm.
- (f) For the size of the space in the socket in front of the eyeball, 0.967 ± 0.078 cm.

2. It was observed that, except the width of the beak, these different characters may be safely used in the selection of good layers.

3. In order to reduce the chances of including some average layers with those that are culled, it is recommended that the following head measurements be used as standard in the selection of good birds:

- (a) For the distance from the base of the comb to the top of the eye, not more than .90 cm.
- (b) For the distance from the top of the eye to the nostril, not more than 1.55 cm.
- (c) For the distance from the base of the comb to the base of the wattle, not less than 3.60 cm.
- (d) For the width of the beak, not less than 1.4 cm.
- (e) For the distance from the base of the comb to the rear of the eye, not more than 1.2 cm.
- (f) For the size of the space in the socket in front of the eyeball, not less than 0.90 cm.

THE EFFECT OF CANE MOLASSES ON THE NITRATE CONTENT OF A CLAY LOAM SOIL KEPT UNDER VARYING CONDITIONS OF MOISTURE¹

H. E. LUMANG AND L. J. VILLANUEVA
Of the Department of Agricultural Chemistry

Molasses which is sometimes considered as a waste product in sugar manufacture may be used to good advantage in a variety of ways. It is an important source of alcohol and is often used, together with bagasse, in some sugar factories as fuel. Its use as fuel is usually the result of several factors, some of which are high labor cost for its disposal, scarcity of fuel, and low market price for molasses. Where equipment for the proper handling of molasses so that it may be utilized as fuel is not installed in a sugar factory, it often becomes necessary to dump it into pits, ditches, and rivers to eliminate it from the sugar-house. Oftentimes, it is thrown in the cane fields with no intention of using it as a fertilizer.

The object of the work reported in this paper was to find out whether molasses when applied to a clay loam soil is beneficial or adverse to plants in general. The work centered on the effects of waste molasses on the transformation of nitrogen in its various forms into nitrates under varying conditions of soil moisture.

It has been conclusively established that nitrogen is chiefly taken up by most agricultural plants in the form of nitrates. The nitrates undergo changes in the soil and their loss or disappearance is always taken as an indication of the need of a fertilizing system which would tend to maintain the supply of this most important plant food.

One of the most important factors which always affect the nitrates present in the soil is soil treatment. The nitrates in the soil as affected by various soil treatments, have been studied by several investigators among whom may be mentioned Brown and Gowda (1924), Halversen (1928), Janssen and Metzger (1928), Jensen (1916), Jones (1928), Lyon (1926), Murphy (1924), and Noyes and Conner (1919). No nitrification studies, however, have been made on the use of waste molasses.

¹ Experiment Station contribution No. 841. Read before the Los Baños Biological Club June 30, 1932. Received for publication August 6, 1932.

PLAN OF THE WORK

The work was conducted in the laboratory of the Department of Agricultural Chemistry. The soil used was taken from a cane field situated between the Biochemistry building and the Sugar Mill of the College of Agriculture. The sugar cane plants were about five months old at the time the sample was taken. The soil was mixed thoroughly, sieved and then air-dried. Two-hundred-twenty grams of the air-dried soil were put in porcelain tumblers. Two-tenths per cent, 1 per cent, 3 per cent and 5 per cent molasses dissolved in just the amount of water required to make up the desired moisture contents of 35, 50, 65, and 80 per cent of the water-holding capacity of the soil was added. The moisture contents were maintained by replenishing the evaporated moisture three times a week. In doing this, the tumblers were weighed and whatever moisture was lost through evaporation was restored by adding distilled water through an open glass tube which extended from above the surface of the soil to an arch at the bottom of the tumbler. This additional piece of glass tubing, as used by Noyes and Conner (1919), was found to be very useful in this work.

All treatments were made in duplicate. Samples for nitrate determinations were taken at the third, fourth, and sixth weeks. In all, three samplings were made. The samples, after being drawn from the tumblers, were immediately placed in the oven to dry. Nitrate determinations were made by the phenoldisulfonic acid method. The nitrate nitrogen was expressed in parts per million of oven-dry soil. Concentrations of less than 1 p. p. m. of nitrate nitrogen were reported as traces.

The soil used was a clay loam. It had a moisture content of 13.54 per cent and a water-holding capacity of 43.6 per cent. Its total nitrogen content was 0.105 per cent and its nitrate content was 4.6 p. p. m.

RESULTS AND DISCUSSION

The effects of the different amounts of cane molasses on the nitrate content of a clay loam soil kept under varying conditions of moisture are given in table 1.

As shown in the table, the adverse effects of 0.2 per cent cane molasses under different conditions of moisture are very noticeable. Only traces and amounts ranging from 1.49 to 2.52 p.p.m. of nitrate nitrogen could be found. None of the treated soils gave a nitrate content higher than those found in the control or in the original

sample. The cause of this decrease is probably due to the amount of cane molasses added. The addition of cane molasses which is a food material rich in carbohydrates, undoubtedly favored the rapid multiplication of the micro-organisms. As a result, the assimilation and consequently the reduction of the original stock of nitrates in the soil took place.

One per cent cane molasses gave an increase in the nitrate content at 65 per cent saturation. Increases over those of the control occurred at the third, fourth, and sixth weeks. These increases at 65 per cent saturation suggest that nitrification was favored by the addition of 1 per cent cane molasses. No nitrates were found at 35 per cent saturation, and small amounts were found at 50 per cent saturation. At 80 per cent saturation, a decrease in the nitrates occurred at the third and fourth weeks. At the sixth week, an increase was noted. These results suggest that nitrification was affected by varying conditions of soil moisture. Adverse effects were noted at 35, 50 and 80 per cent saturation.

Three per cent cane molasses gave the highest amounts of nitrate nitrogen at 65 per cent saturation. Increases over those of the control occurred during the three sampling periods. The nitrates found were 2.5 to 4.3 times the amounts found in the control. Increases were also noted at 50 per cent saturation at the fourth and sixth weeks. At 35 and 80 per cent saturation, traces and very insignificant amounts were found. These were probably due to the unfavorable conditions of soil moisture. The high amounts of nitrates produced at 65 per cent saturation may be due to the increased activity of the nitrifying organisms in the presence of enough food material and an adequate supply of moisture.

The effect of a higher concentration of cane molasses on the nitrate content is very evident. A complete disappearance of the nitrates at the third week occurred at 35 and 65 per cent saturation. At 80 per cent saturation no more nitrates were found at the fourth and sixth weeks. At 50 per cent saturation, decreases in the nitrate content at the third and fourth weeks occurred. At the sixth week an increase which was about twice the amount of nitrate nitrogen in the control was noted. Evidently, nitrification had set in after the second sampling.

It appears that cane molasses greatly affected the nitrates present in the soil kept under varying conditions of moisture. Both the moisture content and the amount of molasses added caused a condition in the soil which was favorable or unfavorable to the growth of the organisms. Where moisture was present in small amounts,

nitrification was almost negligible, but if present in excess a reduction and a consequent loss of the nitrates occurred. The addition of 0.2 and 5.0 per cent molasses was unfavorable to nitrification. Optimum conditions were obtained at 65 per cent saturation in the presence of 3 per cent waste molasses. The nitrates in the soil under these conditions were approximately four times the amounts found in the control at different periods of sampling.

SUMMARY OF CONCLUSIONS

1. Both soil moisture and the amount of cane molasses greatly affected nitrification in clay loam soil.

2. Very little or no nitrates were found at 35 and 80 per cent saturations, using different amounts of waste molasses. These saturations were adverse to nitrification.

3. A very decided increase in the nitrate content was found at 65 per cent saturation, using 3 per cent cane molasses. The nitrates under these conditions were approximately four times the amounts found in the control.

4. Only under special conditions of soil moisture, molasses when applied in adequate amounts favors nitrification. Hence, before waste molasses can be recommended for use as fertilizer, it is advisable that actual field trials be made first.

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TABLE 1

The effect of different concentrations of cane molasses on the nitrate content of a clay loam soil kept under varying conditions of soil moisture

MOISTURE CONTENT ^a <i>per cent</i>	CONTROL			0.2 PER CENT CANE MOLASSES			1 PER CENT CANE MOLASSES			3 PER CENT CANE MOLASSES			5 PER CENT CANE MOLASSES		
	3 weeks	4 weeks	6 weeks	3 weeks	4 weeks	6 weeks	3 weeks	4 weeks	6 weeks	3 weeks	4 weeks	6 weeks	3 weeks	4 weeks	6 weeks
35	7.41	11.27	4.85	trace	trace	2.27	None	None	None	None	trace	1.43	None	None	trace
50	8.48	10.77	4.89	trace	1.49	2.03	3.10	3.94	2.52	3.55	11.87	10.83	4.13	8.62	12.45
65	9.99	9.19	6.44	trace	trace	2.07	10.85	14.20	10.52	23.02	34.83	28.06	None	5.98	4.18
80	7.26	9.45	5.39	2.06	2.52	2.48	1.85	3.48	7.11	trace	1.75	3.72	trace	None	None

^a Based on the water-holding capacity of the soil.

ABSTRACT ¹

A preliminary survey on rural sanitation in Calauan, Laguna. MATIAS P. SUCALDITO. (*Thesis presented for graduation. 1930, with the degree of Bachelor of Science in Agriculture from the College of Agriculture No. 333; Experiment Station contribution No. 842*)

—The object of the survey was to study the condition of sanitation in the municipality of Calauan. The method of survey was direct investigation of such factors as: The general condition of sanitation; houses and their surroundings; disposal of sewage; disposal of garbage and potability of water.

The author's findings were: That the municipality of Calauan has a sanitary ordinance but it is not strictly enforced. That the animals kept under and around the houses make the yard insanitary. That the disposal of garbage and sewage is far from being satisfactory in some sections of the municipality. That the sources of water used in some barrios is polluted while in other barrios it comes from an artesian well and springs in which the water was found to be safe for drinking. That malaria is a common disease in the locality. That the town has a hospital where sick people are treated. The author gives especial credit to the barrios of Malanday and Mabakan for cleanliness.

—Abstract by Cosme O. Reynes

CURRENT NOTES

In 1931, some fifty-six million pounds worth of fruit was consumed, [in Great Britain] of which but ten million pounds worth was produced in the country, the rest being imported from over-seas. In comparison with other foodstuffs, fruit has apparently come to occupy a very important place in the dietary of the nation. The value of the 1931 fruit importations exceeded by twelve million pounds the value of imported wheat and flour, and approximated to three-quarters of that of beef and mutton. . . .

Fruits require very special storage conditions; they have to be kept alive during the storage, but their biochemical processes, such as respiration, must not be entirely suspended. Moreover, disease organisms must be kept in check. These results can only be achieved

¹Abstract prepared as part of the required theme work in English 3a, College of Agriculture.

by very careful attention to temperature, humidity and ventilation, and each kind of fruit requires a different environment in order to permit retarded respiration. Thus, bananas store well at 53°, oranges at 40°, pineapples at 45°, and apples, generally speaking, at 33°F.

Bananas were introduced into the Canary Islands from China before 1500, nevertheless, they were exported to England only in very small quantities, and were almost unknown there even in 1830. The development of the banana trade began between Cuba and New York in the year 1804. The first commercial importations into Europe, were made in 1878 from Madeira, and in 1882 from the Canary Islands. Central American bananas were transported to New York in 1896, and thence to England, but it was not until 1899, as the result of improved methods of refrigeration, that Central American and Jamaican (Gros Michel) bananas reached England in large quantities.

Tropical Agriculture, July, 1932

The rather poor, not to say backward, economic conditions in which the average town and barrio community in the Philippines still finds itself to-day is an open challenge to the increasing number of young school graduates who hail from the small towns and barrios. Most of the rural sections in this country possess abundant means for economic improvement. They have the resources and the man power necessary for greater wealth production. What they lack is leadership. Young men and women with the spirit of progress and enterprise will find in these rural communities a vast field for economic and social pioneering work. Let there be a fuller appreciation among the youth of their great opportunities for leadership and constructive effort in their own home towns and barrios.

Commerce and Industry Journal, Philippines,
April, 1932.

Will the cotton pickers of the South give way to more efficient, if less romantic, harvesting machinery? An improved cotton harvester, exhibited recently in Chicago, supplies the most recent threat to the continued use of hand pickers. When it passes over a field of stalks, cogs revolve and pick the cotton as neatly and thoroughly as human hands can do it. Such is the speed of the machine that it is said to do the work of sixty men. As it is equipped with headlights, the harvester can be used after dark. A wealthy Chicago manufacturer, it is claimed, employed his spare time for six years, and expended half a million dollars, in developing the new invention.

Popular Science Monthly, July, 1932.

Visitors from 23 states attended the fourth annual meeting of the National Council of State Garden Club Federation held at the Copley Plaza Hotel in Boston June, 7, 8, 9, 10. In addition to considering many matters of importance, the delegates, (mostly women) visited many gardens in and around Boston. Mrs. Frank Kellogg of Morristown, N. J. is President of the National Council.

Horticulture, June 15, 1932

The following method of rotating the ground for the staked tomato crop should interest many readers. During the first season the ground is cropped to staked tomatoes, and as the end of the crop approaches, the paddock is fenced off with wire netting and converted into a poultry run. The poultry keep the weeds and any insects in check and maintain the land in bare fallow for one season, after which it is again put down to tomatoes. This country is badly infested with the dreaded nut grass, but the poultry, although not killing the plant, will keep it well in check. Moreover, the soil is enriched as the result of twelve months' accumulation of poultry droppings, giving the young plants good growing condition the following year.

Agricultural Gazette of N. S. W., July 1, 1932

Since 1931, reports the International Federation of Home and School, all pupils in Greek Schools must go to school bareheaded from March to November, wear sandals in place of shoes, and keep blouses or shirts open at the top.

Journal of Home Economics, June, 1932

The prospects of the orange crop are fairly good and more thought is being given to marketing overseas than formerly. New markets for our citrus crop are constantly being sought by the Agricultural Department and others who have the industry at heart. Recently the possibility of supplying oranges to the Dominion of New Zealand has been, and continues to be explored, in order to find out if that country is likely to prove a remunerative outlet for our citrus fruits....

Potential exporters should take particular care to make their "packs" as attractive as possible, and to see that none but the highest quality fruit, sound in every respect, is included in a shipment, as the reputation, not only of the one particular exporter, but that of the whole Island, is at stake. It is well known that poor quality fruit has the effect of depressing the entire market, as well as fetching poor prices itself.

The Cyprus Agricultural Journal, September, 1931.

COLLEGE AND ALUMNI NOTES

Dr. E. B. Copeland has graciously consented to give a series of lectures on Ethics, especially for the students, but the faculty and College community are cordially invited. The first of the lectures was given on August 16 in the Auditorium.

The seventy-fifth meeting of the Los Baños Biological Club was held August 25, 1932, at 7:30 p. m. in the Poultry Husbandry lecture room of the College of Agriculture.

The following papers were read and discussed:

1. "Cinchona Cultivation in the Philippines."

By Ranger Gil Altamirano

2. "Studies on the Germination, Vigor, and Degree of Tillering of Top and Cut-back Seed Pieces of P. O. J. 2878 Sugar Cane."

By Dr. V. C. Calma.

Mr. Nicolas A. Lizares, President of the Talisay-Silay Milling Company, Inc. visited the College on September 7. Mr. Lizares was interested in purchasing a Holstein bull for use in grading up his herd of native cattle for milk production.

Mr. Jose Gomez of La Castellana, Occidental Negros, Dr. Ildefonso Villa-Real of Manila and Pangasinan, and Dr. Isidoro de Santos of Manila were recent Campus visitors. They came to make inquiries as to the progress of their sons who are enrolled in the College.

The Bureau of Reconstruction for Southern China recently purchased from the College through Doctor Baladad one dozen chickens and ten dozen eggs of the Los Baños Cantonese breed. Our Cantonese chicken originated from the region of Southern China but have been improved steadily at the College for the last seventeen years.

About one hundred members of Plant Physiology 1 and of Plant Physiology 101 climbed Mount Maquiling on August 6, 1932. For the first time, 100 per cent of the women members of the lower class reached the top. The party left the Campus at 6:30 o'clock in the morning and arrived at the summit at about 11:00. The return trip was made in shorter time. Leaving the summit at about 12:00 o'clock noon, the party arrived on the Campus early enough to see the U. P. Los Baños vs. U. P. Manila deciding game in basket ball. So the classes were on hand to cheer to victory the Los Baños team. Doctor Espino and Mr. Estioko accompanied the two classes.

The second of the series of illustrated travelogues being given at the Center was on Italy by Dr. A. L. Teodoro, on the evening of August 20. "Sole Mio" sung in Italian by Miss Mamerta Manahan and Mr. Francisco Gomez dressed in Italian costumes gave a realistic touch.

On the evening of September 3, Dean Gonzalez took his audience to Germany in the third of the series. "The Rosary" in German sung by Miss Mamerta Manahan and "Sing Me to Sleep" also in German, by Miss Mamerta Manahan and Mr. Francisco Gomez, gave a "home touch" to the trip.

The Aggie Pen Club elected for the year the following officers.
President, Thuan Komkris
Vice President, Hugo Fernandez
Secretary, Theodore Schuck
Treasurer, Amando Paggao

The following new members were admitted: Rafael Rotor, Salvador Oliveros, Rafael Roces, Mariano Pamintuan, Armando Locsin, Cecilio Antonio and Bernardo Sabolboro. This makes a total membership of fifteen.

Miss Katherine Turner, of the Department of English is Adviser by appointment.

An interesting letter was received recently by Dean Gonzalez, from Hilario M. Turgano B.S.A. '24. He went to Seattle, Washington, U. S. A. in 1927. In his letter he gives a graphic, but not a whining account of his work weeding in a beet sugar plantation and picking strawberries on Puget Sound and digging spuds (potatoes) in eastern Washington. When winter came the cold drove him back to warmer Seattle. In this first winter, with no work and his bank account rapidly diminishing, he heard of the Short Course in Poultry given every winter at the Western Washington Experiment Station at Puyallup. He decided to take it. At the Station, Mr. Turgano writes: "the people were kind, helpful and friendly.

"At present, I am employed by the Dickey Ranch, Puyallup, one of the leading Poultry Breeding Plants in U.S.A. For three years I have stuck to the job, helping in brooding and trapnesting of the Dickey Strain (Single Comb White Leghorn.)"

Mr. M. E. Gutierrez, '17, is now Acting District Agronomist under the Bureau of Plant Industry for the provinces of Isabela and Nueva Vizcaya. His official station is Ilagan, Isabela.

Mr. Silverio M. Cendaña, '21 Fellow of the University of the Philippines at the University of California, was elected to membership in Phi Sigma, honorary society in biology, on March 3, 1932.

Mr. Eulalio P. Baltazar, '22, M.S. '24, instructor in agronomy at the College and now on detail at the University of Texas, was elected to membership in Sigma Xi, honorary scientific society, on April 12, 1932.

Mr. Fidel del Rosario, '30, assistant entomologist in the Bureau of Science, visited the College on August 17 to confer with Dean Gonzalez and his former professors regarding his proposed work in the United States. He was recently appointed a Rockefeller Fellow to pursue advanced work in entomology in Johns Hopkins and in Cornell University.

Mr. Candido L. Bagaoisan '31, Agronomist of the Iwahig Penal Colony visited the College on September 2 and 3. He was interested in securing planting material of various kinds, especially sugar cane, for introduction in the colony. Mr. Bagaoisan was on vacation leave and on his return to his station he expected to take with him a life partner.

The Central Azucarera de La Carlota wrote Dean Gonzalez recently requesting the assignment of five senior students for work in that central during the coming milling season. In addition to a liberal emolument the students are furnished free passage from Manila to Negros and vice versa.

CROPS AND CIVILIZATIONS

The title of this article is a very comprehensive one, and within the limits of space available to me only certain aspects of the subject can be presented. There is, however, a distinctly interesting series of correlations which I shall attempt to summarize in this brief address. It is self-evident that agriculture is basic to all advanced civilizations. It is equally evident that all cultivated plants and all domesticated animals were derived from wild ancestors, some time during the development of the human race and, for the most part, early. We are apt to take our cultivated plants and domesticated animals for granted and seldom give thought to whence they came, when, where and by whom the plants were brought into cultivation and the animals domesticated, how, when and by whom they were disseminated. The facts are in general approximately known, but the inferences to be drawn from these facts are too often ignored.

It is well known that practically every cultivated food-producing plant and all domesticated animals now found within the limits of the United States were introduced from other regions. Some years ago while residing in the Philippines it occurred to me that in that tropical archipelago, covering a water area of approximately 600,000 square miles, the same statement was true; that all the cultivated food-producing plants and all domesticated animals now found in the archipelago were exotic, having been introduced in the past from various parts of the world, some in the prehistoric period, others within historic times. It was found that other very large areas in various parts of the world presented the same story. It gradually dawned upon me that here was a fertile field for investigation. In reference to the United States, the Philippine Islands and other large areas in the world the questions arise: Where did these agricultural plants and animals originate? When, how and by whom were they introduced into the regions where they now occur? What limitations, other than climate, inhibited the universal distribution of important food plants and animals up to about 500 years ago?

It is well known that every important food-producing cultivated plant was already in cultivation and every important domesticated animal was already in domestication at the dawn of recorded history. In the agricultural experience, slowly built up by many peo-

ples through the long period of pre-history, was laid the basis of all civilizations. It is, of course, axiomatic that before a civilization could develop anywhere, there must be a constant and dependable food supply, and this our remote ancestors insured during their long period of agricultural development. While modern man has accomplished much in plant and animal breeding, increasing quality and yield, and ensuring a more dependable food supply through breeding for disease resistance, yet after all it may be doubted if any modern development in plant and animal breeding equals the accomplishments of our very remote and uncultured ancestors who brought the very numerous plants and animals basic to agriculture in from the wild and developed them to serve their needs under domestication. It is rather strange that, in spite of the tremendous advances man has made in the past few hundred years, in this period, outside of numerous ornamentals, he has actually domesticated very few species of plants and no animals; and the few plants domesticated are not food-producing ones, but rather those which yield products in great demand in modern trade, such as *Cinchona* (quinine), *Hevea* (Para rubber), abacá or Manila hemp, and other medicinal, oil and fiber producing plants. The culture of many species has been very greatly extended, such as coffee, tea, cacao and numerous others, but these were all in cultivation many centuries ago, either in Eurasia or America, but none were known outside of the continental areas where they originated before the advent of European exploration.

If one surveys the world in relation to the places of origin of agricultural plants and domesticated animals, it becomes evident that vast areas originally produced nothing of consequence in the plant or animal kingdom as far as agriculture is concerned. Thus all North America, north of Mexico, all Australia, much of Africa, and large areas in Asia, Europe and South America added practically nothing to our stores of plants and animals basic to agriculture. The centers of origin of the more important species are peculiarly restricted and, what is perhaps of even greater interest, these centers of origin of agricultural products correspond rather closely with those regions in which ancient civilizations were developed. A combination of favorable climatic conditions; native plants or plants and animals of importance in the production of food and that were more or less readily adapted to domestication as a basis of a permanent food supply; potential mental ability on the part of the local

pioneers of civilizations; and, perhaps, fortuitous circumstances, all had their part in this period of pre-history, as far as man and his civilization is concerned.

The centers of origin of civilizations and of agricultural plants in America are in general two rather restricted regions with equable climates; the highlands of Mexico in North America and Yucatan; in Eurasia, Asia Minor, certain parts of the Mediterranean basin, and restricted areas in India, China and central Asia correspond to the few centers of origin in America. And what is again of distinct interest is that in these centers of the beginnings of ancient cultures the independent civilizations were built primarily on the basis of certain definite plants and animals native of each region. Thus in Peru, the potato and various beans were basic; in Mexico, the most important food plant was maize, or Indian corn; in Asia Minor, and perhaps in some parts of the Mediterranean basin, the basic foods were our standard cereals, barley, wheat, rye and oats; and in India and in China, rice. In each center there were, of course, secondary food-producing plants, including various vegetables and fruits and in most or all centers certain animals were of distinct importance.

Without going into detail it is of interest to note in general the origin of basic agricultural plants and animals, as between the old and the new worlds.

The food plants of Eurasian origin are the common cereals, such as wheat, rye, barley, oats, rice, millet, Italian millet, sorghum, pearl millet and others of minor importance, such as ragi, teff and coix; in this category for convenience buckwheat may be placed, although it is not a true cereal; among the vegetables are the turnip, cabbage, rape, radish, beet, parsnip, carrot, onion, leek, garlic, shallot, spinach, egg-plant, lettuce, endive, salsify, celery, asparagus, pea, soy-bean, cow-pea, chick-pea, pigeon-pea, lentil, broad-bean, hyacinth-bean, asparagus-bean, taro and the yams; among the fruits are the apple, pear, plum, cherry, European grape, apricot, peach, prune, olive, fig, almond, persimmon, quince, pomegranate, melon, watermelon, cucumber, and in the warmer regions the banana, coconut, all citrus fruits, including the orange, lime, lemon, and pomelo, date, mango, bread-fruit, jakfruit, rambutan, litchi, longan, lansone, mangosteen, and others. The domestic animals of Eurasian origin include all breeds of cattle, horses, water buffaloes, yaks, sheep, goats, swine, ducks, geese, hens and pigeons. These are the basic agricultural foods of the entire eastern hemisphere. Of course, many of them are limited in their range by climatic conditions, and from the standpoint of European civilizations, many of the plants that will thrive

under European climatic conditions, and some of the animals, did not actually reach Europe until well into the period of recorded history; some were introduced in very modern times. The point I wish to make is that they are all natives of some part of the Old World and none were known in America previous to Columbus' voyage in 1492.

While the list of food plants and domesticated animals native of Eurasia is an impressive one, certain very important items are lacking; these are essentially the agricultural products on which the American civilizations were based. The basic food plants of American origin include but one cereal, but this is a very important one, maize or Indian corn; in addition, there are such vegetables as the potato, sweet potato, lima bean, all varieties of our common garden and field beans, tomato, pepper, Jerusalem artichoke, squash, pumpkin, quinoa, peanut, and in the more strictly tropical regions cassava, arrowroot, chayote and such fruits as the papaya, avocado, pineapple, custard-apple, soursop, cherimoya, sapote, sapodilla, cacao, cashew, and others. The domesticated animals were peculiarly few, the llama and alpaca in South America, and the turkey in Mexico. These are the basic agricultural products on which the American civilizations were based, and none of them were known in Europe or Asia previous to 1492, even as none of the longer Eurasian list were known in America before that date.

Various problems appertaining to ancient civilizations in America have intrigued many investigators, and numerous theories have been proposed to explain certain resemblances between these pre-Columbian American civilizations and those of Eurasia on the basis of supposed contacts across the Atlantic and the Pacific. It is, however, a curious and incontrovertible fact that previous to 1492 not a single cultivated food plant of major, or even secondary, importance, or a single domesticated animal, except the dog, was common to both hemispheres. Briefly, this means agriculture was developed independently by primitive man in America strictly on the basis of American plants and animals and that the early American civilizations were developed on the basis of this agriculture. It is only within the past five centuries that there has been a general world-wide dissemination of the basic food plants and domesticated animals. The resemblances between the early American and the Eurasian civilizations are apparently only fortuitous. The conclusion that one draws on the basis of biogeographic distribution of plants and animals basic to agriculture is that there were no contacts of importance between Eurasia and America previous to 1492. Had

there been in the long period of pre-history only fortuitous and accidental contacts, and these only at long intervals, after the development of agriculture, the first items to be transmitted across the ocean would be seeds and tubers of food-producing plants, that is, those items essential to the maintenance of life, rather than the more advanced arts of architecture, hieroglyphic writing, and political, civil and ecclesiastical organization. It is the history of primitive invading or colonizing peoples in such vast areas as Malaysia and Polynesia that they took their food plants with them in their migrations, just as at a later date Europeans colonizing America brought their familiar agricultural plants and animals with them, and established them in their new homes. It is certain that, had any considerable number of these agricultural items of Eurasia been transmitted to America before 1492, or *vice versa*, at least some of them would have persisted in cultivation in their new homes, so that when Europeans actually commenced the exploration of America they would have found somewhere cultivated food plants with which they were familiar at home. What they did find was an agriculture based on a series of plants and animals totally unfamiliar to them and for the most part representing natural groups (genera) different from those of Europe and Asia.

E. D. MERRILL

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The most interesting new agricultural project in the Philippines the *Journal* knows of is a citrus plantation on Buad Islands, on the southeastern coast of Samar, being developed by the Buad Plantation Company. The company has W. Roeder, a young Swiss, in charge down there. To date it has spent about ₱75,000, with excellent results reported both in its prospectus and independently by the Plant Industry Bureau. . . .

The company has in its orchards now, thousands of them in the bearing stage, 8,000 budded citrus-fruit trees.

There are 400 citrus medica, the rind of which makes the candied citron of commerce. At the age of 1½ years these trees are bearing. There are 1,000 calamondin trees, a fruit which seems to be unique

to the Philippines and is known at Manila under the name of calamanci. In appearance it resembles a very small orange. Its juice is more tart than orange juice, less tart than lemon juice, and the juice content is very high. Fresh, the calamondin is used like lemon. The company proposes to commercialize the juice.

There are 2,500 limes of 7 budded varieties, domestic and foreign. The oldest lime trees are 3 years old and 6 of the varieties are bearing. There are also 2,500 lemon trees, of 2 budded varieties. To produce a thoroughly standard lemon, the company sprays its trees regularly and encases the growing lemons in paper bags. . . .

The American Chamber of Commerce Journal,
September, 1932. (Manila, Philippines)

The cow to me means the entire sub-human world. Man through the cow is enjoined to realize his identity with all that lives. Why the cow was selected for apotheosis is obvious to me. The cow in India was the best companion. She was the giver of plenty. Not only did she give milk, but she also made agriculture possible. This gentle animal is a poem of pity. Protection of the cow means the protection of the whole dumb creation of God. . . . Cow-protection is the gift of Hinduism to the world.—GANDHI

Civilization is the process of moving from one set of loyalties to another. As we grow, the loyalties become larger and wider. If we are going to live in the twentieth century, we cannot keep our feet in the eighteenth.—RAYMOND B. FOSDICK

FLORAL MORPHOLOGY OF THE MANGO
(MANGIFERA INDICA LINN.) WITH SPECIAL REFERENCE
TO THE PICO VARIETY FROM THE PHILIPPINES¹

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WITH FIVE PLATES

Morphologically, the family Anacardiaceae to which the mango belongs, has received very little attention, although some of its genera are known to yield fruits of economic importance. In an attempt to make a comparative morphological study between *Rhus* and *Coriaria*, Grimm (1912) was able to trace the development of the pollen grains and the female gametophyte in *Rhus toxicodendron*. Recently, Juliano (1932) attributed the non-production of the seeds in *Spondias purpurea* Linn., a plum of local importance, to the fact that the microspore mother-cells (pollen mother-cells) failed to develop and hence no microspores or pollen grains are formed in the microsporangies. He found the female gametophyte to be normal, and that the megagamete was never fertilized. In *Spondias lutea* Linn. and *S. cytherea* Sonn., two imported species normally producing seeds, the formation of pollen grains was observed.

In mango (*Mangifera indica* Linn.) Strasburger (1878) observed the presence of several embryos in a juvenile seed. He attributed this phenomenon to the formation of adventitious embryos from the nucellus. Cook (1907) reported even as many as eight embryos arising from a single seed of this plant, and, like Strasburger, he concluded that the extra embryos were nucellar in origin, although Cook, himself, failed to ascertain whether the "strong" embryo came from the fertilized megagamete. Belling (1908), working on No. 11 race of polyembryonic mangoes from Florida, found that the adventitious embryos were nucellar in origin, and he never found the megagamete, whether fertilized or not, giving rise to any of the embryos.

Of the six different varieties of mangoes (Carabao, Pico, Dudul, Binoboy, Señora and Pahutan) described by Wester (1920), only one

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(Dudul) was reported not polyembryonic. A case where six embryos all developing at one time from a single seed of Carabao mango was pictured by Wester (1920). Mendiola (1926) stated that ten or even thirty seedlings may grow from a single Carabao or Pico seed. These two questions then arise: (1) Are all the embryos that develop in the seed of our native polyembryonic mangoes, with special reference to the Pico variety, also nucellar in origin? (2) Does the zygote, or fertilized megagamete take an active part in the formation of any or all of the embryos in a single seed? These are questions pertinent to the hybridization of the mango tree. A study, therefore, of the morphology of the flowers as well as of the young seeds may throw some light on the true nature of the embryos formed in our native Pico mango seed. This study includes an account of the organography of the flowers, the development of the gametophytes, and a description of the pericarp of the fruit.

MATERIAL AND METHODS

The material used in this study was gathered during the months from March to June of the years 1927, 1931, and 1932 from mango trees, Pico variety, growing on the College Campus. Inflorescences, flowers, fruits and seeds at different stages of development were gathered and fixed in the field and in the laboratory. Formalin-acetic-alcohol and chromo-acetic stock solution prepared according to the formulae given by Chamberlain (1924) were used as fixatives. The material was embedded in paraffin, cut 8 to 10 microns thick, and stained in Heidenhain's iron-hematoxylin with a counterstain of orange Gold dissolved in clove oil. Safranin-Delafield's hematoxylin combination was also used to some extent, especially on sections of the mature fruit.

Our Pico mango trees on the Campus produce hundreds and even thousands of flowers in each panicle but only a few or none of the hermaphrodite flowers ever continue to form fruits. Torres (1931) reports that under normal field conditions the percentage of setting in Carabao mango varies from 0.5 to 3.0 per cent. In each ovary one megasporange, very rarely two, is formed. Consequently, the writers were forced to cut thousands of specimens representing each stage of development in order to obtain fairly conclusive pictures of the normal course of development, a condition seldom met with by investigators working with a material possessing an abundance of megasporanges in a single ovary.

INVESTIGATION

Inflorescence and flowers

The profusely branched inflorescence of mango develops at the terminus of the individual branch, and bears numerous polygamous flowers. The flowers are yellowish white in color, and are mainly clustered towards the apices of the branchlets of the inflorescence. The individual flower is borne on short stipitate and articulate pedicel, and is subtended by a deciduous and caducous bract. The hermaphrodite flower possesses four or five ovate to lanceolately concave, pale green sepals, which are pubescent. Within the calyx whorl and alternating with the calyx lobes are five free petals, which are elliptic, lanceolate to ovate-lanceolate, and inserted at the base of a fleshy disk. These petals are twice as long as the sepals. The stamens are five in number, the one opposite the style usually becoming functional, while the others degenerate (pl. 1, fig. 9). In some cases one or two of the staminodes may become large and capitate, and actually produce scanty pollen grains. Cases where three stamens become functional are not uncommon. The functional stamen is composed of a slender filament, surmounted by an oval, reddish purple anther, dehiscing longitudinally. The disk is obscurely 5-lobed and hemispherical, on which sits a unicarpous, 1-celled, oblique, globose ovary, bearing a lateral slender style and a single megasporange, or ovule within. Occasionally, two megasporanges may be formed within the ovary, one of which is very much smaller than the other, and neither one, except occasionally, producing normal megagametophytes. The megasporange is at first atropous (pl. 1, fig. 6) with its funiculus attached to the base of the ovary wall, but later it becomes anatropous and pendulous as the ovary matures (pl. 1, fig. 9). It possesses two integuments (pl. 5, fig. 45) which fuse quite early. The fused integuments cover the micropyle of the megasporange (pl. 3, fig. 35) upon maturity.

On the other hand the male or staminate flower possesses an abortive carpel (pistil) (pl. 1, fig. 11) which does not develop to any appreciable extent, but remains as a degenerated structure within the disk. The perianth as well as the stamens found in the hermaphrodite flowers are also developed in this staminate flower.

The hermaphrodite flower starts as a mammillate protrusion from the axil of the tertiary bract borne on the branchlet (pl. 1, fig. 3) of the rachillae (pl. 1, fig. 2) of the panicle inflorescence (pl. 1, fig. 1). The first floral organ to develop on the individual floral primordium are the sepals, which appear as a marginal ring of four

to five lobes on the side of the floral cone (pl. 1, fig. 3). These calyx lobes grow straight up, and simultaneous with this upward growth of the sepals, the next floral organ or the petals begin to differentiate as hemispherical outgrowths within the calyx whorl (pl. 1, fig. 4). These newly developed petals are rather slow to grow at first, so the calyx rather than the corolla encloses the other organs of the juvenile flower. Later, these petals grow more rapidly than the sepals and cover the internal organs until anthesis. Within the petals a single whorl of five stamens then develops as conical masses just opposite the calyx lobes and alternating with the petals (pl. 1, fig. 5, 7 and 8). Only one of the five stamens ever develops to maturity, and this occupies a greater portion of the area enclosed by the corolla. In some cases, however, one or more of the staminodes or degenerated stamens may begin to develop and form scanty pollen grains. The last floral organ to be formed is the carpel (pistil) which bears a single megasporange (pl. 1, fig. 9). The development of the floral organs of the hermaphrodite flower of the Pico mango is, therefore, acropetal. Its organs arise as follows: sepals, petals, stamens, and carpel. The same order of development of the floral organs was reported in *Spondias purpurea* Linn. (Juliano, 1932) and the coconut (Juliano, 1926; Juliano and Quisumbing, 1931).

The development of the floral organs of the male, or staminate flower follows that of the hermaphrodite flower in that they arise centripetally. In the male flower the carpel remains as a degenerated structure within the disk (pl. 1, fig. 10-11) and never develops to any appreciable extent.

Microsporangia and microspores

Of the five stamens arising from the individual hermaphrodite as well as from the staminate flowers, only one ever reaches maturity (pl. 1, fig. 9 and 11) and forms microspores or pollen grains. In some male and hermaphrodite flowers, several of the stamens may start to develop and show an apparently normal development, forming few and scanty pollen grains. Very early this functional stamen differentiates into a slender filament and an enlarged anther which is 4-lobed in transverse section (pl. 2, fig. 12). Under each lobe a row of three to seven hypodermal cells differentiate (pl. 2, fig. 13) which equal the whole length of the microsporangia. These archesporial cells can easily be distinguished from the rest of the surrounding cells by their large amount of cytoplasm, large nuclei, and affinity to stains. Very soon these archesporial cells divide

periclinally and thus give rise to an outer layer of primary parietal cells and an inner layer of primary sporogenous cells (pl. 2, fig. 13). By periclinal or tangential walls, the single layer of primary parietal cells forms two layers of parietal tissue (pl. 2, fig. 14). These two layers of parietal tissue or only the outer layer of cells may divide periclinally once, in which case three to four layers of parietal tissue are generally developed (pl. 2, fig. 15-17) in the mature microsporangium. In all cases the innermost layer of the parietal tissue becomes the tapetum, and the outermost layer, the endothecium.

The primary sporogeneous cells after having been formed, enlarge and become polygonal in shape, thus clearly differentiating themselves from their adjacent cells (pl. 2, fig. 14). They possess an abundance of thick cytoplasm and distinctly large nuclei with well defined nuclear membranes (pl. 2, fig. 15). By subsequent divisions of these primary sporogenous cells a mass of microspore mother-cells is formed (pl. 2, fig. 16-17). By the time these microspore mother-cells are in synapsis (pl. 2, fig. 17 and 24), they all separate *en masse* from the tapetal layer. They then round off and proceed to divide. The division of the microspore mother-cells is simultaneous (pl. 2, fig. 18-21) as is true of many dicotyledonous plants. The tetrads just formed are at first enclosed by the wall of the mother-cell (pl. 2, fig. 21) and by the time this common wall has disappeared, the microspores have already acquired their own walls (pl. 2, fig. 22). The mature microspores before dehiscence (pl. 2, fig. 23) each possesses two distinct coats, within the inner one of which is a rounded nucleus.

Among the cells of the parietal tissue which are the first to differentiate are those of the innermost tapetal layer. The tapetal cells which are at first polygonal in shape (pl. 2, fig. 14) elongate radially (pl. 2, fig. 15-16) and their nuclei undergo active division. By the time the microspore mother-cells are in synapsis, a majority of the nuclei of the tapetal cells bordering the epidermis of the microsporangium have already divided, while those located nearer the connective may still be resting or in the process of division (pl. 2, fig. 24). When the tetrads are formed, all the tapetal cells are binucleate. This behavior of the tapetal cells in the Pico mango is similar to that reported for *Silphium* (Merrell, 1900), where the tapetal cells were at first uninucleate, later becoming binucleate as they enlarge and mature.

The outermost layer of the parietal tissue, like that of the tapetum, next undergoes differentiation during the maturation of microsporangium. This outermost layer or endothecial cells enlarge and

elongate radially (pl. 2, fig. 25), and this enlargement apparently crushes the middle layer or layers of the parietal tissue (pl. 2, fig. 26). These enlarging endothelial cells which are at first parenchymatous, possess scanty peripheral cytoplasm and comparatively small nuclei. Later, their inner and radial walls thicken, and their nuclei gradually degenerate and disappear as the microspores are dehiscid (pl. 2, fig. 26).

The epidermis surrounding the lobes of the microsporangium also exhibits a very distinct peculiar behavior. When the sporogenous cells are fully differentiated or even earlier (pl. 2, fig. 14-17) the epidermal cells bordering the individual lobes of the anther greatly enlarge periclinally, and this enlargement apparently provides plenty of space for the increase in number and size of the cells within the microsporangium. This enlargement is greatest in those epidermal cells situated at the summit of the lobes, and correspondingly decreases towards the two sides.

Megasporangium and megagametophyte

The pistil is unicarpous and bears a lateral style at its juvenile stage (pl. 1, fig. 9). Its ovary is 1-celled, and possesses within a single anatropous megasporangium, which later becomes pendulous. This single megasporangium starts as a basal mamillate outgrowth (pl. 1, fig. 6) within the carpel wall, and grows upward until it completely fills up the ovarial cavity (pl. 1, fig. 9). This origin of the megasporangium is identical to that reported for *Loranthus* and *Rhopalocnemis phalloides* (Coulter and Chamberlain, 1903), and in coconut (Quisumbing and Juliano, 1927). By one-sided growth this nascent megasporangium is bent downward, and becomes anatropous (pl. 3, fig. 35). From thence the megasporangium and the ovary increase in size at a rather uniform rate until after fertilization whence the ovary grows and enlarges much faster than the megasporangium.

By the time the integuments which arise in acropetal succession are fully developed, a single hypodermal cell differentiates on the summit of the nucellus, and this functions as an archesporial cell. Unlike that reported for *Rhus* (Grimm, 1912) this archesporial cell in *Mangifera* does not function direct as a megaspore mother-cell. Instead, it divides periclinally into an outer primary parietal cell and an inner primary sporogenous cell (megaspore mother-cell) and is, therefore, similar to that found in *Spondias purpurea* Linn. (Juliano, 1932). The primary parietal cell, together with the rest of

the micropylar nucellar cells, gives rise to a rather extensive parietal tissue which pushes the megaspore mother-cell way deep in the nucellus (pl. 3, fig. 27-28).

The primary sporogenous cell or megaspore mother-cell does not divide soon after it has been formed from the archesporial cell. Instead it enlarges, becoming distinctly polygonal in shape and differentiates greatly from the rest of the nucellar cells. This growth takes place simultaneously with the development of an extensive parietal tissue. Its nucleus enlarges and its cytoplasm increases in amount and becomes thick. Soon it enters synapsis (pl. 3, fig. 28) and by two successive divisions, a row of four daughter megaspore cells (tetrads) are developed (pl. 3, fig. 29). The chalazal daughter megaspore cell, which becomes functional, gives rise to the normal seven-celled megagametophyte. The degeneration of the three micropylar daughter megaspore cells does not always take place at the same time, as the second may only show signs of disorganization long after the other two have degenerated (pl. 3, fig. 29). However, the chalazal daughter megaspore cell always functions and forms the megagametophyte in this variety of mango (pl. 3, fig. 30).

The functional daughter megaspore cell then elongates, and this elongation is accompanied by the formation of distinctly large vacuoles (pl. 3, fig. 29-30). Its nucleus then assumes a central position, where it finally divides, and gives rise to two daughter nuclei. These two daughter nuclei migrate separately to the two poles of the embryo sac (pl. 3, fig. 31), and by two successive nuclear divisions they form a normal seven-celled megagametophyte as is usually reported in many Angiosperms. This same megagametophytic development has been observed in *Rhus* (Grimm, 1912) and *Spondias purpurea* Linn. (Juliano, 1932).

The mature megagametophyte shows a distinct egg-apparatus (two synergids and an egg or megagamete), a fusion nucleus, and three antipodals. The two synergids (pl. 3, fig. 32a) are at first irregular in shape and later become pyriform, and are devoid of the so-called "filiform apparatus" (pl. 3, fig. 33). They possess scanty peripheral cytoplasm and a large central vacuole, and their nuclei are located at their bases directed towards the micropyle. These synergids are ephemeral in nature, and usually begin to show signs of degeneration as soon as the nucellar cells commence to break down owing to the enlarging embryo sac. The megagamete which possesses a dense cytoplasm and a rather large nucleus, usually lies behind the two synergids (pl. 3, fig. 32a and 33).

The polar nuclei fuse quite early, and the fusion nucleus which results from the union of the two polar nuclei may be found normally near the egg-apparatus (pl. 3, fig. 33), seldom at the chalazal end of the sac, and rarely at the middle. This fusion nucleus remains at the micropylar end of the embryo sac until it is ready to initiate the formation of the nuclear endosperm (pl. 3, fig. 34).

The antipodals (pl. 3, fig. 32b), like the synergids, are also ephemeral in nature, and they degenerate simultaneously with the synergids or even earlier, and long before endosperm formation begins. They do not form distinct walls and behave very much like those found in *Spondias purpurea* Linn. (Juliano, 1932).

The pericarp

Soon after fertilization the perianth segments, bracts, and stamen dry up, and nothing remains on the flower except the pistil and the disk. The pistil starts to form the fruit and the disk remains as a dark dry ring around the base of the juvenile fruit. The mature fruit of the Pico mango is a drupe consisting of a rather thick pericarp enclosing a large seed which is polyembryonic. It is oblong-ovoid, varying from 10 to 15 centimeters in length, and somewhat compressed, greenish in color when young, and yellowish green when ripe. The mature pericarp is composed of (a) a rather tough *exocarp* or rind, (b) an extensive fleshy and edible *mesocarp*, and (c) an *endocarp* which develops an outer stony layer and inner papraceous thin membrane.

At the time the megaspore mother-cell is in synapsis, the pericarp still appears as a homogeneous mass of parenchymatous isodiametric small cells, delimited on both surfaces by distinct rectangular or squarish cells within and palisaded epidermal cells without. The outer epidermis is coated on its outer tangential walls with a thin cuticle, while the inner epidermis remains thin-walled. Just prior to fertilization of the megagamete, the homogeneous pericarp undergoes complete differentiation and change (pl. 5, fig. 48). The cells occupying the middle portion of the pericarp enlarge. Some become oblong to slightly elongated, while others may remain isodiametric, and this change is accompanied by the formation of intercellular spaces. The elongated cells have their large diameters parallel to the long axis of the fruit. The outer epidermis of the pericarp becomes palisaded and these cells are covered by a comparatively thick cuticle, while the four to five layers of hypodermal cells remain isodiametric and small. The inner epidermal cells remain small and squarish, and the six to eight layers of hypodermal

cells also remain small and are isodiametric. The second layer of hypodermal cells just below the inner epidermis shows slight enlargement and these become the forerunner of the separation tissue in the endocarp which is discussed below. The hypodermal cells below the inner epidermis are much smaller than those below the outer epidermis. Thus the pericarp becomes now fully separable into three distinct regions; namely, (a) an *exocarp* consisting of palisaded outer epidermis of the pericarp with four to five hypodermal layers of small isodiametric cells, (b) a central *mesocarp* of homogeneous mass of large, oblong, elongated to isodiametric cells, and (c) the *endocarp* composed of the inner squarish epidermis of the pericarp and six to eight layers of small isodiametric hypodermal cells.

Exocarp

The exocarp prior to the lignification of the stony layer is composed of many layers of rounded, oblong to elongated thin-walled cells, interspersed here and there by longitudinally directed laticiferous glands which become larger inward (pl. 5, fig. 50). It is delimited on the outside by the outer epidermis of the pericarp which now consists of rather small bulging irregularly set cells with a covering of very thick cuticle on their outer tangential walls. Their continuity is broken up here and there by the presence of stomata. The first few hypodermal cells are small, oblong, and tangentially compressed, and the succeeding ones are rounded to elongated, leaving air spaces between.

The laticiferous glands are long ramifying canals the interior of which is lined with small secretory cells. These secretory cells are of various shapes. Surrounding these secretory cells on the outside are two to four layers of thin-walled cells below which are found the small vascular bundles often associated with the glands. These laticiferous glands run parallel to the long axis of the fruit, and are mostly confined to the exocarp, although a few may be found in the endocarp.

In the exocarp small vascular bundles which consist mostly of tracheid-like cells surrounded by thin-walled polygonal to rectangular conducting elements run with the laticiferous glands, and are often associated with them. In some exocarp cells calcium oxalate crystals are found.

Mesocarp

The mesocarp occupies the greatest bulk of the pericarp of the fruit. It consists of a mass of large homogeneous much elongated.

oblong to rounded cells interspersed with enormous cellular spaces. This tissue is traversed by small, numerous vascular bundles representing the ramification of the vascular supply from the endocarp, and are widely separated by the ground tissue of the mesocarp. When the fruit becomes ripe, the walls of the parenchymatous cells break down, and the whole tissue becomes soft, pulpy, juicy, and edible.

Endocarp

The endocarp consists of the inner palisaded epidermis of the pericarp (pl. 5, fig. 49) below which are (a) a layer of small isodiametric cells and (b) four to five layers of rather large oblong cells with their large diameters at right angles to the long axis of the fruit. These large parenchymatous cells are not traversed by any vascular bundles. Within these tissues lies a region of small prosenchymatous to oblong cells which become larger towards the mesocarp. These cells are traversed longitudinally by numerous vascular bundles which are surrounded by numerous prosenchymatous elements. The vascular bundles are separated from each other by few to several layers of large, oblong to rounded parenchyma with conspicuous air spaces between. Groups of cells of the endocarp may become highly elongated in any direction so that in this tissue are found interlacing masses or groups of prosenchymatous elements.

Stony layer. When the fruit is mature and nearly ripe, the vascular bundles as well as the ground tissue they occupy become highly lignified, and together form a solid stony layer or shell which consists of groups of elongated lignified prosenchymatous elements (pl. 5, fig. 51, 56-57), which may be elongated, curved or branched (pl. 5, fig. 52). Their tips may be rounded (pl. 5, fig. 57) or bent (pl. 5, fig. 58), and in a few cases even bifurcated (pl. 5, fig. 54). Among these prosenchymatous lignified elements are found associated tracheid-like thick-walled cells, which are lignified and provided with simple pits (pl. 5, fig. 53 and 55). The toughness of the stony layer and its ability to stand cutting or shearing action is mainly due to the peculiar interlacing arrangements of bands of lignified elements.

Membrane. The inner palisaded epidermal cells of the pericarp also become lignified (pl. 5, fig. 59) and in extreme cases even the small hypodermal isodiametric cells (pl. 5, fig. 60). The epidermal cells exhibit characteristics of the typical stone cell with thick lignified striated walls and traversed by short to elongated canals or pits. The hypodermal layer of cells are rounded and lignified, and

their lumina are larger than those of the epidermal cells. This lignified epidermis together with the lignified hypodermal layer readily separates from the stony layer or shell within as a thin, papyraceous, rather pliable membrane. This separation is due to the destruction of the thin-walled parenchymatous cells which are slightly and faintly lignified.

The seed

In the development of fruits containing viable seeds, pollination is necessary. On March 24, 1932, one hundred thirty-four flowers were emasculated between six and seven o'clock in the morning (Torres, 1931), and no fruit ever developed from them. This result confirms the findings of Popenoe (1917). However, fruit formation is not always followed by the development of a normal seed as some pistils have been observed by the writers to have reached a fairly good sizeable stage without any seed within. These fruits are much smaller than those containing normal viable seeds.

The seed of mango lies within a hard stony layer or shell and a thin, papyraceous membrane, both of which are derived from the endocarp. It is oblong to kidney-like in shape, and is covered by coats which are almost always broken on one side. The coats consist of an outer dark chocolate layer, the *testa*, and an inner light chocolate membrane, the *tegmen*. The outer membrane is smooth and the inner surface of the inner membrane is rough.

At the time the megaspore mother-cell is fully differentiated the megasporange fills the ovarial cavity until after fertilization (pl. 3, fig. 35). Later, the ovary begins to enlarge at a much faster rate than the developing young seed within. The seed is thus left to lie in a much enlarged ovarial cavity for a long time or until about maturity of the fruit when it again nearly fills the entire hole within the pericarp.

Zygote. The zygote (pl. 3, fig. 34) does not divide at once after fertilization, but stays dormant even after endosperm formation is underway (pl. 3, fig. 37-38). The synergids soon disappear (pl. 3, fig. 36-38), and simultaneous with their disappearance the embryo sac enlarges and elongates with its enlarged portion directed towards the micropyle. The nucellar cells surrounding the embryo sac become densely filled with thick cytoplasm, especially at the micropylar end. Belling (1908) reports that in no case was the megagamete, whether fertilized or not, ever seen by him to give rise to any of the embryos in the sac of polyembryonic mangoes (No. 11)

in Florida. This is not, however, the rule with the Pico mango. The zygote, which may hibernate for a long while in the embryo sac, persists and is easily distinguishable (pl. 3, fig. 34, 36 and 38). It divides transversely (pl. 4, fig. 39), giving rise to a basal elongated cell and a rounded apical cell, and as shown in plate 4, figure 41 the zygote actually gives rise to a four-celled embryo. One peculiar thing about the embryo of the Pico mango is the complete absence of any suspensor.

The zygote in all probability gives rise to a larger and far more developed embryo in the sac (pl. 4, fig. 43-44) as compared with those developed from the other portions of the megasporange. Its development is much ahead of that of the other embryos.

In one case the zygote seems to show signs of degeneration (pl. 3, fig. 37) and its membrane tends to disorganize. It does not divide and all indications are that it will not produce an embryo. Endosperm nuclei are present in abundance and, therefore, fertilization must have taken place. This peculiar behavior of this zygote is taken by the writers as a sign that this variety of mango is on its way to complete sterilization similar to that reported by Belling (1908) in the No. 11 race of mangoes in Florida. Pico mango has not yet become sterile, and its megagamete when fertilized is capable of giving rise to normal embryo.

Adventitious embryos. As enlargement of the embryo sac and destruction of the nucellar tissue take place simultaneously, some of the micropylar nucellar cells become greatly differentiated from the adjoining cells, as they possess distinctly large nuclei, and dense cytoplasm; also their response in behavior to stains differ (pl. 4, fig. 40-41). These cells are usually deep-seated in the micropylar portion of the nucellus, and as soon as their adjoining cells have degenerated, they begin to develop and divide (pl. 4, fig. 40) forming adventitious embryos. A nearly similar method of development of extra embryos was reported in *Citrus trifoliata* (Osawa, 1912), *Funkia*, *Nothoscordon*, *Citrus aurantium*, *Evonymus*, *Coelobogyne*, *Clusia*, *Opuntia*, and others (Coulter and Chamberlain, 1903).

From three to four well-developed embryos are commonest in the material the writers have examined. Belling (1908) reports as many as half a dozen adventitious embryos, all developing at one time in the sac of the polyembryonic mangoes (No. 11) in Florida. The embryos derived from the nucellar cells then project into the embryo sac and exhibit irregularity in shape. A great variety of size is displayed by them, and they lack, usually, the presence of

well-developed suspensors. The embryo derived from the zygote is usually larger than any of the embryos formed from the nucellar cells (pl. 4, fig. 43-44).

In seeds which show no sign of endosperm formation one is apt to find the characteristic enlargement and development of some of the nucellar cells (pl. 4, fig. 42). No zygote is present and the tendency of a few of the nucellar cells to enlarge and differentiate from the rest of the nucellar tissue is enough evidence to show that these cells are inherently capable of developing embryos under favorable conditions.

Endosperm. Fusion of the polar nuclei takes place either at the chalazal end or at the micropylar end of the embryo sac (pl. 3, fig. 33-34) adjacent to the egg-apparatus, where it may remain for some time during the enlargement of the embryo sac. The endosperm of mango is of the nuclear type, and its development follows that of many angiosperms. As soon as or even long after the synergids have already disappeared, the primary endosperm nucleus usually migrates to the middle portion of the much elongated embryo sac where it finally begins to enter into an active division (pl. 3, fig. 36). Many series of free nuclear divisions follow (pl. 3, fig. 38) and the nuclei may lie scattered in the embryo sac. Later, these free endosperm nuclei assume a peripheral position where they lie in a layer of cytoplasm. This peripheral cytoplasm is thickest at the ends of the embryo sac.

The endosperm becomes cellular first at the micropylar end of the embryo sac from where it proceeds to the chalaza. The endosperm tissue completely fills the embryo sac, and is later absorbed by the developing embryos.

The nucellus is not wholly destroyed by the endosperm and a portion of it may remain on the sides of the embryo sac as a thin tissue consisting of rather small isodiametric outer cells and radially elongated inner cells towards the endosperm (pl. 5, fig. 46). This nucellar tissue is not absorbed completely by the developing embryos in the seed. Its remains may be seen in the mature seed as a dense crumpled mass of material, staining rather deeply and adhering to the inner coat, the tegmen, of the mature seed (pl. 5, fig. 47).

Seed coats. At the time the megasporange is at the megaspore mother-celled stage, the two integuments which arise in acropetal succession are easily distinguishable (pl. 5, fig. 45). The inner integument is much less developed than the outer integument, and consists of two layers of cells, becoming three at its free end.

On the other hand the outer integument is more massive than the inner and is faintly separable from it. Very early in their development the two integuments fuse and develop together covering partially or even completely the micropyle of the megasporange (pl. 3, fig. 35). The vascular supply to the megasporange is mostly confined to the inner portion of the outer integument. This homogeneity of the integuments continues until the seed is quite large.

Just prior to the lignification of the stony layer of the pericarp the seed coat becomes separable into distinct layers (pl. 5, fig. 46). The outer portion, or *tegmen* consists of numerous vertically elongated cells, some of which may be isodiametric. The walls are made up of cellulose and tend to become smaller inward. Those nearer the outside have already degenerated and only walls remain as a compressed mass. At the innermost portion of the tegmen are the vascular bundles. The inner portion, or *testa* consists of small radially compressed cells which become rectangular to oblong towards the nucellus.

At maturity of the seed, it becomes covered with dark, rather tough and crushed cells forming more or less a mass of overlying cell walls enclosing at its inner portion the remains of the vascular bundles (pl. 5, fig. 47). The inner portion, or *tegmen* remains undestroyed and is composed of rather elongated cells which become larger towards the inner portion of the coat. The roughness of the tegmen is due to the irregular deposition of nucellar material on its inner surface. The coats are both slightly impregnated with lignin, but lignification is much more pronounced in the outer coat than in the inner coat. These are separable because of the difference in the degree of lignification of their component cells.

SUMMARY

The profusely paniculate inflorescence of the Pico mango (*Mangifera indica* Linn.) arises from the terminus of the individual branch and bears numerous polygamous flowers. The individual flower (hermaphrodite as well as staminate) arises as a mammillate protusion at the axil of the tertiary bract borne on the branchlet of the paniculate inflorescence.

The development of the floral organs of both hermaphrodite and staminate flowers is acropetal, and they arise as follows: sepals, petals, stamens, and pistil. In the staminate flower, the pistil becomes abortive.

Usually only one of the stamens becomes functional, but occasionally one, two or in rare cases even three of them may elongate

and develop a few scanty pollen grains. Very early the functional stamen forms the filament and the anther. A plate of three to seven archesporial cells differentiate under each lobe and these divide periclinally forming an outer primary parietal layer and an inner primary sporogenous cells. The primary parietal layer gives rise to a parietal tissue of three to four layers of cells, the outermost layer of which becomes the endothecium, while the innermost functions as the tapetum. The tapetal cells which are at first uninucleate become binucleate in the mature microsporangium. The intermediate layer or layers of the parietal tissue are crushed by the growth of the endothecial layer which greatly enlarges radially in the mature stamen.

By subsequent divisions of the primary sporogenous cells a mass of microspore mother-cells is formed, and these divide simultaneously in developing the tetrads or microspores.

The single megasporangium within the ovary starts as a basal mammillate outgrowth within the carpel wall, and this grows upward until it completely fills the cavity. By one-sided growth the megasporangium becomes anatropous, and later pendulous as the ovary matures. By the time the integuments are fully formed, a single hypodermal archesporial cell differentiates at the summit of the nucellus of the megasporangium, which divides periclinally into a primary parietal cell and an inner primary sporogenous cell. The primary parietal cell together with the micropylar nucellar cells form a thick parietal tissue which buries the primary sporogenous cell way deep in the nucellus. The primary sporogenous cell by two successive divisions forms a row of four daughter megaspore cells, the chalazal megaspore daughter cell of which becomes functional.

A normal seven-celled megagametophyte is formed. The synergids and the antipodals are all ephemeral in nature and very early disintegrate.

After fertilization the zygote remains dormant for some time, and later gives rise to an embryo. A case of degeneration of the zygote is described. The adventitious embryos are all derived from the cells of the nucellus at the micropylar portion of the embryo sac, and are belated in growth.

The endosperm is of the nuclear type, and its development follows that of many of the dicotyledonous plants. It completely fills the embryo sac and is totally absorbed by the developing embryos at the maturity of the seed.

The pericarp of the fruit very early differentiates into three distinct regions or layers; namely, (a) an exocarp, (b) a fleshy me-

socarp, and (c) an endocarp. The endocarp contributes to the formation of the stony layer and the papyraceous membrane within the stone.

The two integuments of the megasporange early fuse and give rise to two distinct coats in the mature seed. The nucellus is not completely absorbed; part of it remains on the inner portion of the tegmen of the seed.

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EXPLANATION OF THE PLATES

Parts of the inflorescence, the flower, the fruit and the seed are designated as follows: antipodals (*an*), primary bract (*b*), secondary bract (*br*), carpel (*c*), calcium oxalate (*cr*), megagamete or egg (*e*), endothecium (*ed*), endocarp (*en*), endosperm (*end*), exocarp (*ex*), fusion nucleus (*fn*), laticiferous gland (*gl*), inner coat or tegmen (*ic*), inner integument (*ii*), inner epidermis of the pericarp (*ip*), mesocarp (*m*), microspore or pollen grain (*mi*), nucellus (*n*), ovule or megasporange (*o*), outer coat or testa (*oc*), outer integument (*oi*), petal (*p*), parietal tissue (*pa*), primary parietal layer (*ppa*), primary sporogenous cells (*ps*), rachilla (*r*), sepal (*s*), stamen (*st*), synergid (*sy*), tapetum (*t*), tertiary bract (*tb*), vascular bundle (*vb*), and zygote (*zy*).

PLATE I

- Fig. 1. Longitudinal section of a portion of a young inflorescence showing the origin of the rachillae at the axils of the primary bract. $\times 18$.
 Fig. 2. Longitudinal section of a rachilla showing the origin of the secondary branches at the axils of the secondary bract. $\times 38$.
 Fig. 3. Longitudinal section of a floral primordium showing the development of the sepals. $\times 66$.
 Fig. 4. An older hermaphrodite flower showing the petals already differentiated. $\times 66$.
 Fig. 5. Longitudinal section of a hermaphrodite flower showing all its parts fully formed. $\times 66$.
 Fig. 6. Longitudinal section of the carpel showing the origin of the megasporange. $\times 66$.
 Fig. 7. Longitudinal section of a much older hermaphrodite flower showing the development of only one of the stamens. $\times 66$.
 Fig. 8. Diagram of the transverse section of the hermaphrodite flower showing the relative positions of all its parts. $\times 38$.
 Fig. 9. A mature hermaphrodite flower which is about to open showing the relative positions of its parts. $\times 31$.
 Fig. 10. Longitudinal section of a staminate flower showing its parts already differentiated. $\times 38$.
 Fig. 11. A much older staminate flower with all its parts fully developed. $\times 38$.

PLATE II

- Fig. 12. Diagram of a transverse section of the anther. $\times 66$.
 Fig. 13. Portion of the same anther showing outer primary parietal layer and inner primary sporogenous cells. $\times 706$.
 Fig. 14. An older microsporangium showing the two layers of parietal cells and the subsequent enlargement of the primary sporogenous cells. $\times 593$.
 Fig. 15. A much older microsporangium showing three layers of parietal tissue. Note radial enlargement of the tapetal cells. $\times 593$.
 Fig. 16. Portion of a longitudinal section of an older microsporangium showing the microspore mother-cells, the tapetum, and two to three layers of parietal tissue. $\times 593$.
 Fig. 17. A very much older microsporangium showing microspore mother-cells in synapsis. $\times 593$.

- Fig. 18. Microspore mother-cell in telophase of the heterotypic division. $\times 706$.
 Fig. 19. Microspore mother-cell in very late telophase of the heterotypic division. $\times 706$.
 Fig. 20. Later stage of the heterotypic telophase after appearance of the nuclear membrane. $\times 706$.
 Fig. 21. Tetrads. Note wall of mother-cell. $\times 706$.
 Fig. 22. Tetrads. $\times 706$.
 Fig. 23. Mature microspore before dehiscence. $\times 706$.
 Fig. 24. Portion of a transverse section of the microsporangium showing the microspore mother-cells in synapsis and the division of some of the nuclei of the tapetal cells. $\times 706$.
 Fig. 25. Portion of a longitudinal section of the microsporangium showing the endothecium, and the binucleate tapetum. Observe the radial enlargement of the endotheacial cells, and those of the epidermis $\times 593$.
 Fig. 26. A much older microsporangium showing the degeneration of the tapetum, and the thickening of the walls of the endothecium before dehiscence. $\times 356$.

PLATE III

- Plate 27. Portion of the apex of the nucellus showing the megaspore mother-cell and the two parietal cells. $\times 593$.
 Plate 28. Megaspore mother-cell in synapsis. Note the thick parietal tissue derived from the activity of the primary parietal cell and the nucellar cells. $\times 593$.
 Plate 29. Tetrads; note the early degeneration of the megaspore daughter cells, and the enlargement of the chalazal megaspore daughter cell. $\times 706$.
 Fig. 30. Uninucleate megagametophyte; note the remains of the degenerated micropylar megaspore daughter cells. $\times 706$.
 Fig. 31. Binucleate megagametophyte. $\times 706$.
 Fig. 32a. Egg-apparatus. $\times 706$.
 Fig. 32b. Antipodals. $\times 706$.
 Fig. 33. An older egg-apparatus and the fusion nucleus ready to be fertilized. $\times 593$.
 Fig. 34. A much older egg-apparatus after fertilization; note degeneration of the synergid. $\times 593$.
 Fig. 35. Diagram of a longitudinal section of the pistil showing the position of the style and the megasporangium. $\times 32$.
 Fig. 36. First division of the primary endosperm nucleus; note the zygote. $\times 326$.
 Fig. 37. Degenerating zygote, and free endosperm nuclei. $\times 593$.
 Fig. 38. Zygote and free endosperm nuclei. $\times 326$.

PLATE IV

- Fig. 39. Two-celled embryo derived from the fertilized megagamete and free endosperm nuclei. $\times 593$.
 Fig. 40. Showing some nucellar cells differentiating; one of them has actually divided giving rise to adventitious embryo. Section from fig. 39.
 Fig. 41. Four-celled embryo derived from the fertilized megagamete, and five nucellar cells beginning to form adventitious embryos. $\times 593$.

- Fig. 42. Portion of the longitudinal section of an unfertilized megasporange showing three nucellar cells beginning to develop. $\times 593$.
- Fig. 43. Longitudinal section of the embryo sac showing three embryos, two lateral ones coming from the nucellus, and the middle one from the fertilized megagamete. $\times 32$.
- Fig. 44. Another megasporange showing four embryos; the largest came from the fertilized megagamete. $\times 32$.

PLATE V

- Fig. 45. Portion of a longitudinal section of a megasporange showing the two integuments. $\times 530$.
- Fig. 46. Transverse section of the coats of the young seed; note the nucellus and endosperm towards the embryo sac. $\times 117$.
- Fig. 47. Diagram of the transverse section of the coats of the mature seed. $\times 117$.
- Fig. 48. Portion of the longitudinal section of the young pericarp showing differentiation of the exocarp, mesocarp, and endocarp. $\times 117$.
- Fig. 49. Portion of the transverse section of the endocarp including a portion of the mesocarp before lignification. $\times 117$.
- Fig. 50. Portion of the transverse section of the exocarp and a part of the mesocarp before lignification. $\times 117$.
- Fig. 51-52, and 56-57. Macerated elements of the shell or stony layer derived from the endocarp. $\times 117$.
- Fig. 53 and 55. Tracheid-like elements from the macerated stony layer. $\times 117$.
- Fig. 54 and 58. Showing bifurcated and bent apices, respectively, of the lignified prosenchymatous elements of the stony layer. $\times 326$.
- Fig. 59. Portion of a transverse section of the thin, papyraceous, pliable membrane derived from the endocarp showing lignification of the epidermis (inner epidermis of the pericarp). $\times 593$.
- Fig. 60. Portion of a transverse section of a more mature membrane derived from the endocarp. $\times 593$.

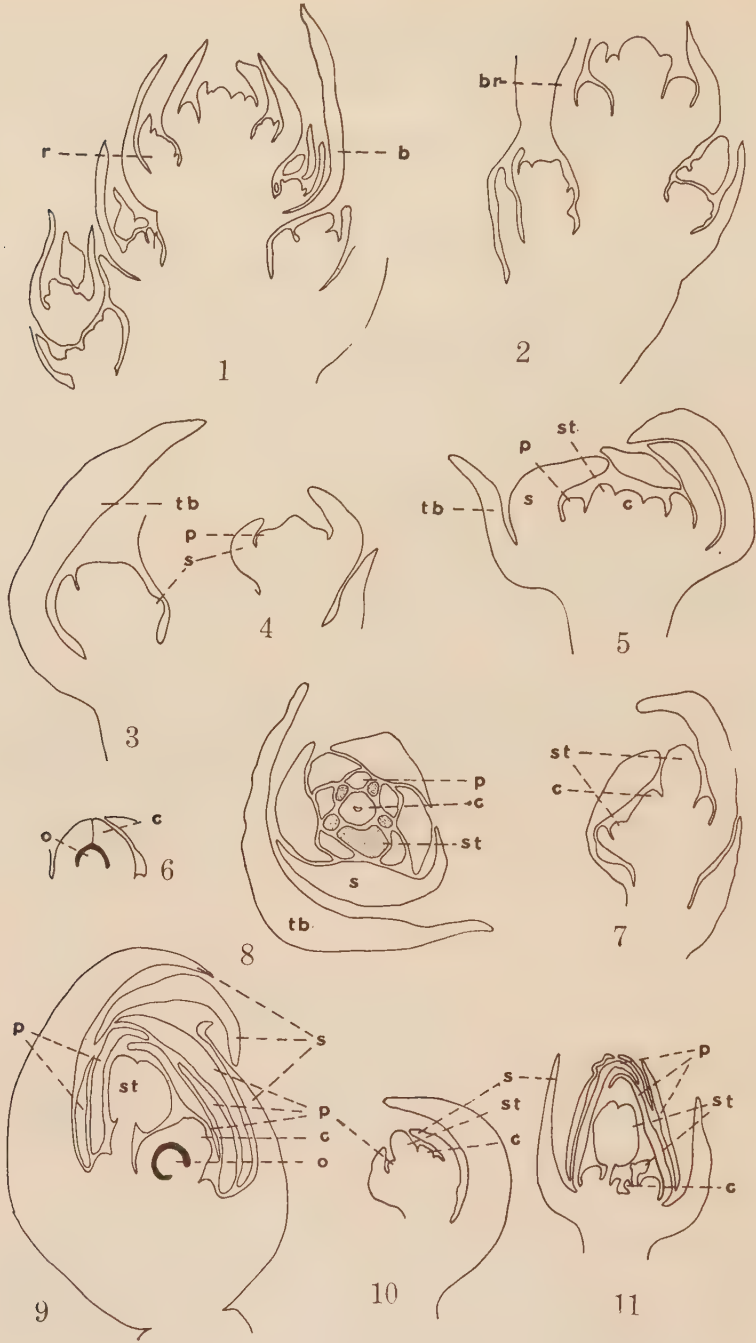


PLATE I

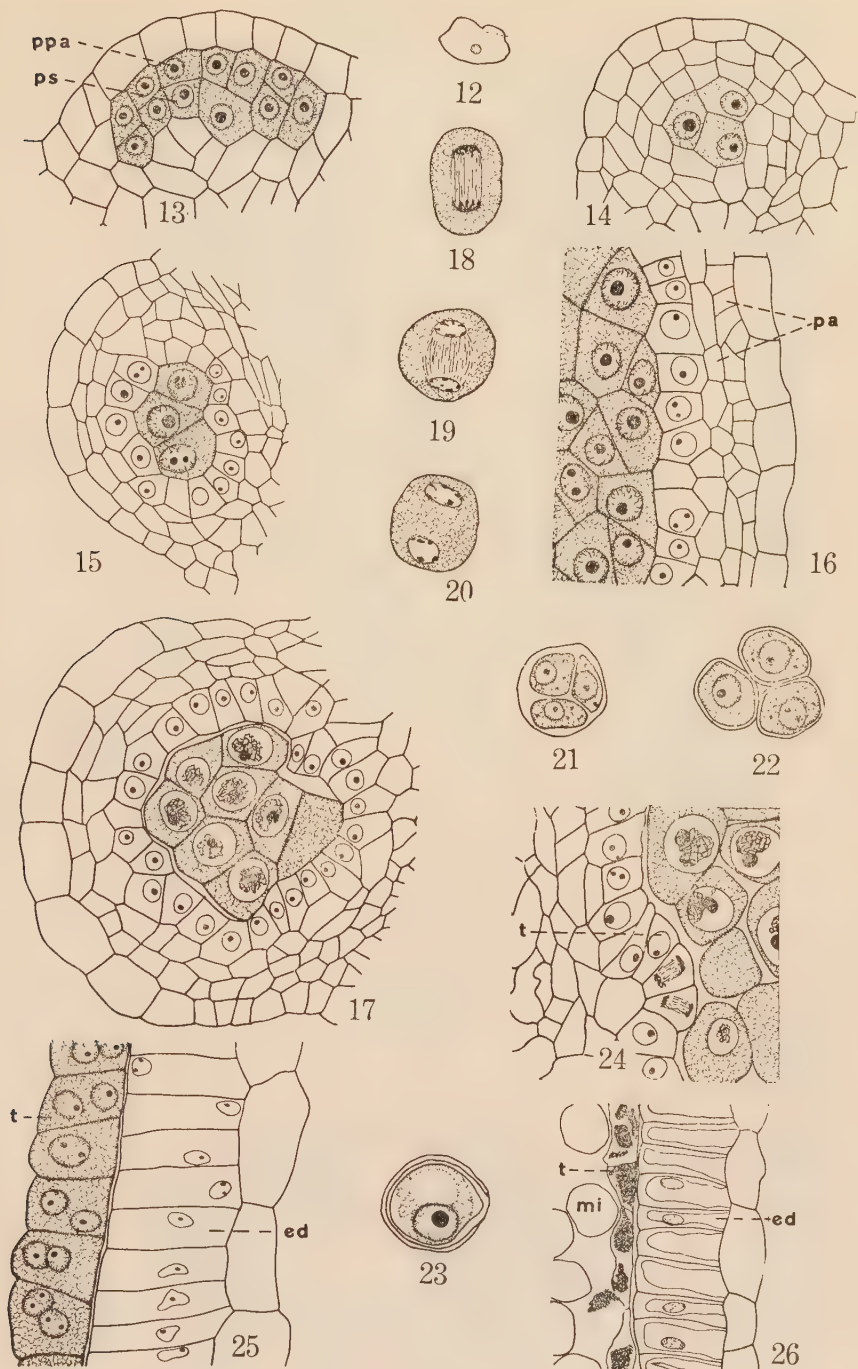


PLATE II

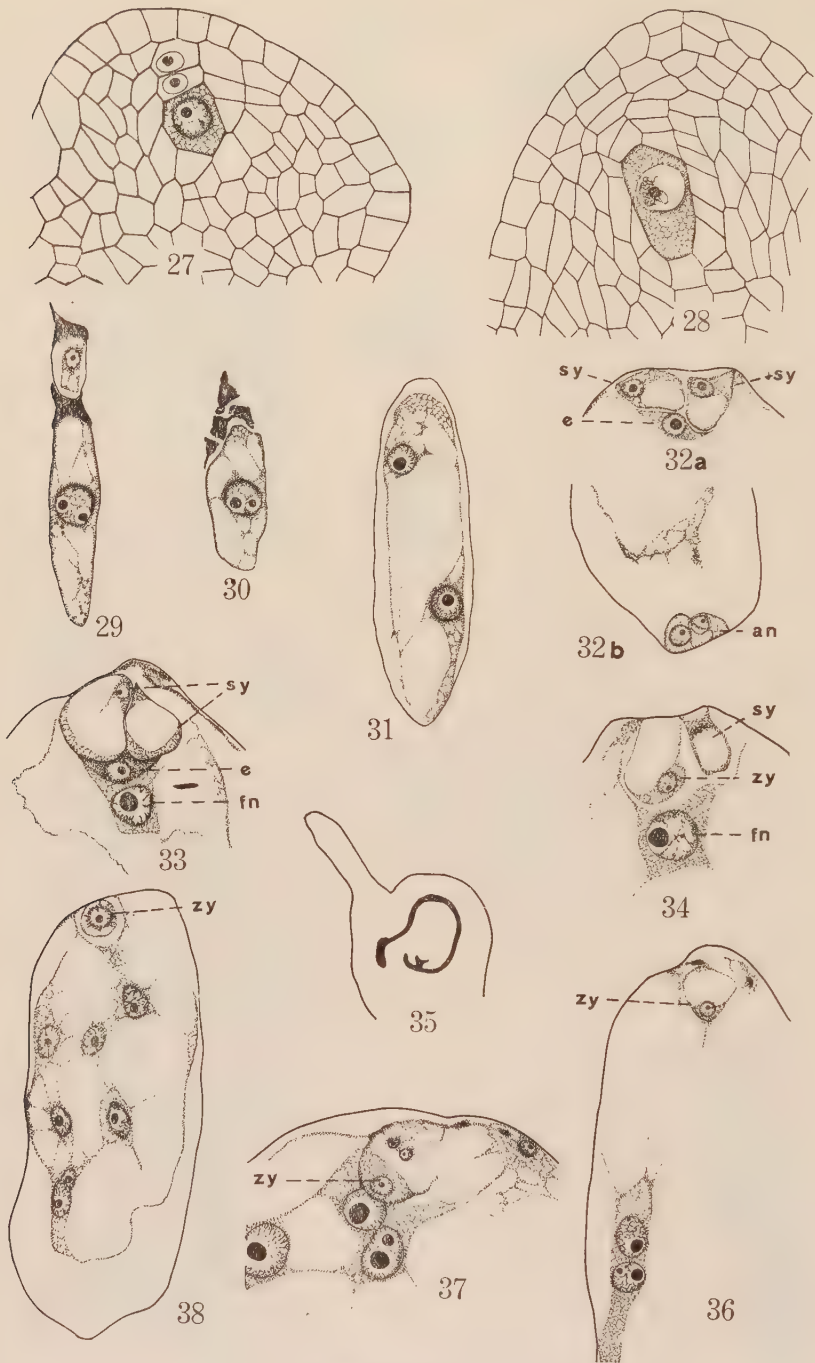


PLATE III

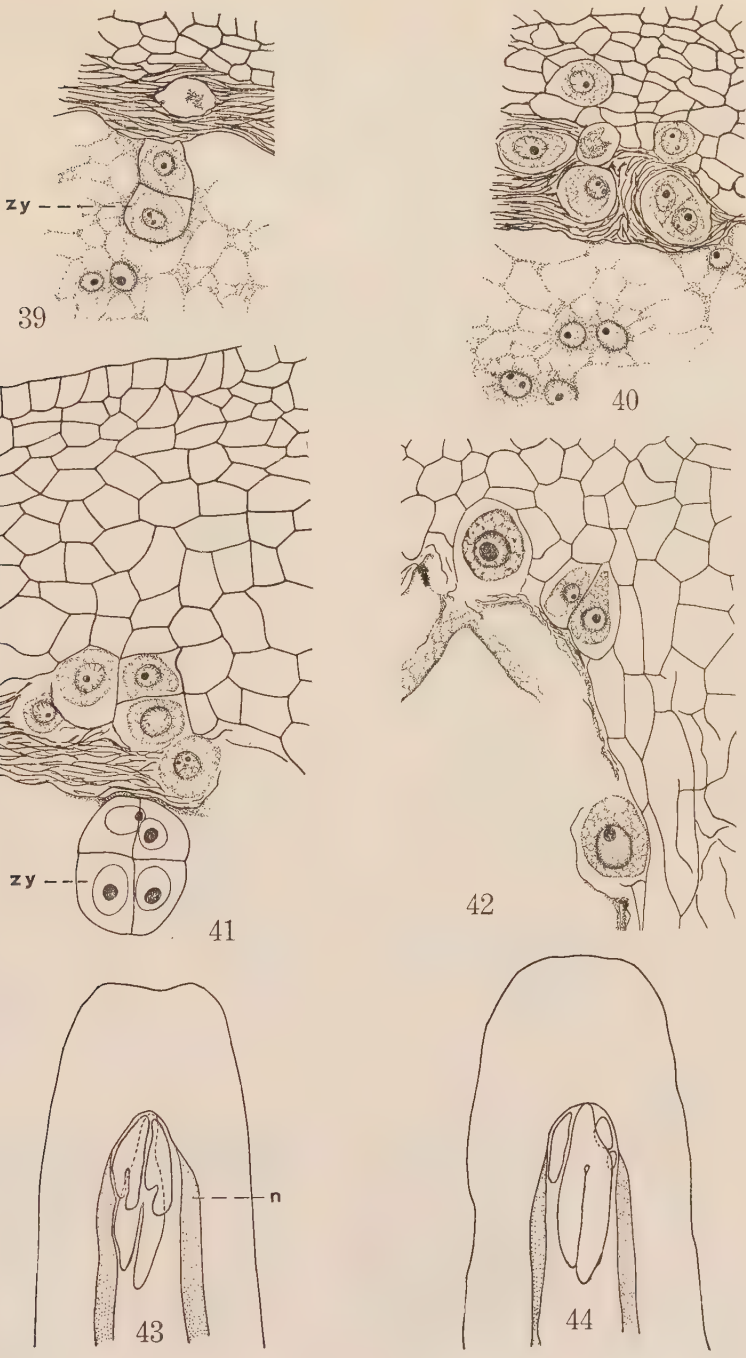


PLATE IV

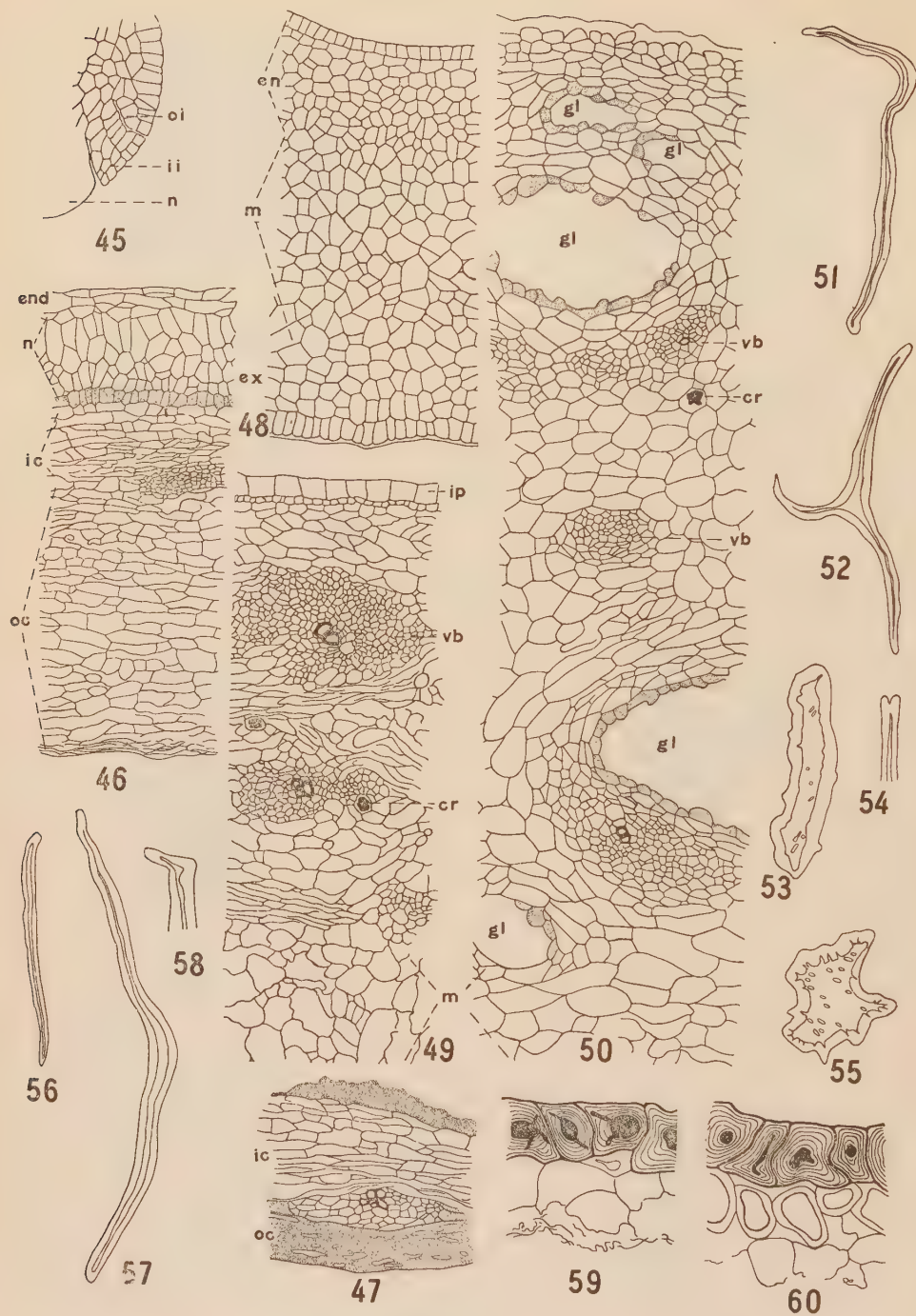


PLATE V

EFFECTS ON HATCHABILITY OF HOLDING EGGS IN A LOW TEMPERATURE ¹

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The geographical location of the Philippine Islands makes the importation of improved fowls for use either in starting a standard-bred flock or in improving such flocks as are already existing in the Islands, an important problem with poultry raisers. A practicable solution of this problem would undoubtedly be of great help not only to Philippine poultry raisers, but also to those in other countries who might desire to export fowls to or import fowls from this country.

Fronda and Gonzalez (1929) reported the case of thirty Nagoya eggs which, in 1926, were brought to the College of Agriculture, Los Baños, from Tokyo, Japan. The eggs were packed in rice hulls in a box and stored in the vegetable refrigerating room of the ship. Fourteen chicks, or 47 per cent, were hatched out of the thirty eggs. This hatch was considered remarkable, for the eggs were on the ship about a week and the seas crossed were rough.

This experience suggests the possibility of importing eggs of improved breeds into the Philippines rather than importing the birds themselves. By importing the eggs, the danger of introducing disease would be minimized or wholly avoided; and the cost and the trouble would be less than bringing in the fowls. The questions that may be asked then are: What are the possibilities of importing eggs by way of the refrigerating room in numbers sufficient for breeding? How will the hatchability be affected if eggs are held for varying periods of time in a low temperature prior to placing them in the incubator?

To answer these questions, a series of experiments in which eggs were held in a low temperature for varying periods of time were conducted in the College of Agriculture, Los Baños. The experiments were begun in June, 1929 and closed in May, 1930.

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² The data reported in this paper were taken from a thesis presented March, 1932 by the junior author for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, University of the Philippines.

REVIEW OF LITERATURE

Edwards (1902) fixed the developmental zero of the hen's egg at a temperature lying between 68°F. (20°C.) and 69.8°F. (21°C.). Lippincott (1927) after considering the results of studies made by various investigators, including those of Edwards, stated that to be sure of securing the complete cessation of the development, which is under way at laying, eggs must be kept in a temperature below 68°F. (20°C.).

When eggs are kept in a refrigerator at 32.9°F. (0.5°C.) for 24 hours, Dougherty (1926) cited Mauro's (1923) observations that eggs were not appreciably affected. But when held at this temperature for 4 hours, the capacity of the embryos to develop was considerably reduced and after 72 hours, it was entirely destroyed. Mussehl and Bancroft (1924-25) corroborated the results of Mauro's observations. These two investigators reported that exposure of hatching eggs to a temperature of 32°F. (0°C.) for 6 to 18 hours did not lower their hatching power, but when hatching eggs were held at this temperature for as long as 36 hours, a reduction in hatching power was indicated.

Elford (1921) reported that when a number of lots of hatching eggs packed in different ways were exposed to temperatures ranging from 14° to 26°F. (-10° to -3.3°C.), eggs with strong germs stood more cold than it has been generally believed they could. However, Lewis and Thompson (1924) observed that hatching eggs produced after a blizzard were low in fertility and the embryos of the fertile eggs were subnormal.

Dougherty (1926) cited the results of the studies made by Colasanti in 1875 on the effects of low temperatures on hatchability. In these studies, it was observed that hen eggs that were immersed for one to two hours in an ice bath ranging in temperature from -4°C. to -10°C. were practically frozen through when removed from the bath. After eight days of incubation, these eggs showed apparently normal embryonic development as compared with control lots of eggs which had not been immersed in the ice bath. The results obtained by Rabaud (1899) and by Mancini (1908), as cited by Dougherty (1926), are quite similar to those obtained by Colasanti. Mancini concluded that the germ, while dormant, is less sensitive than after development has begun.

In his report on the effect of low temperature on hatchability of eggs, Dougherty (1926) gave the following conclusions:

1. Exposure of hatching eggs to temperature of 28° to 32°F. (-2.2° to 0°C.) for one to three successive nightly periods of 14

hours each did not seem to have any detrimental effect on their hatching quality.

2. Exposure of hatching eggs to temperatures of 28° to 32°F. (-2.2° to 0°C.) from three successive nightly periods plus a continuous period of 38 hours did not result in any significant reduction in the percentage of chicks hatched.

3. Exposure of hatching eggs to temperatures of 28° to 32°F. (-2.2° to 0°C.) for four successive nightly periods plus a continuous period of 38 hours did result in a reduction in the percentage of chicks hatched.

These results seem to indicate that long-continued exposure to low temperatures is probably detrimental to the hatching quality of eggs. The results of observations on holding eggs at temperatures ranging from 5° to 16°C. for periods of one to four weeks are reported in this paper.

EXPERIMENTS AND RESULTS

In these studies, 2,400 Cantonese eggs were used. In the first series of experiments, there were six hatches divided into two parts. In each hatch, there were five lots of 50 eggs each. None of the eggs selected were more than one day old. The different lots in the first part were held as follows:

Lot 1, the control, was held for one week under ordinary conditions. The temperature ranged between 25° and 30°C. In the first part of the first series the temperature of the refrigerator ranged from 5° to 7°C. Lot 2 was held in the refrigerator for one week; lot 3, for two weeks; lot 4, for three weeks; and lot 5, for four weeks.

The second part of the first series consisted of the fourth, fifth and the sixth hatches and was the same as the first part except that the temperature of the refrigerator ranged from 8° to 12°C. That is, the refrigerator temperature was from 3° to 5°C. higher in the second part than in the first.

In the second series there were also three hatches. The objects of the tests in this series were to determine whether the length of time of holding eggs, or the low temperature in the refrigerator, or both the length of time and the low temperature affected their hatchability. The eggs were divided into the following lots:

Lot 1, the control for lot 2 was held for two weeks under ordinary room conditions where the temperature ranged from 25° to 30°C. Lot 2 was held in a refrigerator where the temperature varied for 6° to 11°C.

Lot 3, the control for lot 4, was held for three weeks under ordinary room conditions. Lot 4 was held in a refrigerator where the temperature ranged from 6° to 11°C. for three weeks, the same length of time that lot 3 was held.

Lot 5, the control for lot 6, was held for four weeks under ordinary room conditions. Lot 6 was held in a refrigerator for four weeks at a temperature varying from 6° to 11°C.

All hatching eggs used in this experiment that were placed in the refrigerator were packed with excelsior in boxes. That the eggs might not remain in the same position for more than 24 hours, the containers were turned daily. The eggs that were kept under ordinary room conditions were placed on their side, and were turned daily.

The results obtained in the first set of the first series of hatches are summarized in table 1.

TABLE 1

Showing the results of the three hatches in the first series. Hatches were made in August, September and October

LOT NO.	NUMBER OF EGGS IN LOT	TEMPERATURE	TIME IN REFRIGERATOR	HATCHABILITY			
				1st hatch	2nd hatch	3rd hatch	Average
		°C.	weeks	per cent <i>b</i>	per cent	per cent	per cent
1	150	25—30	— ^a	40	50	56	48.7
2	150	5—7	1	56	44	54	51.3
3	150	5—7	2	0	38	42	26.7
4	150	5—7	3	0	10	6	5.3
5	150	5—7	4	0	4	6	3.3

^a Held for 1 week under ordinary room conditions.

^b From all eggs set. There were 50 eggs in each lot for each hatch.

It will be noted in table 1 that except in the first hatch, eggs hatched in all lots that had been held in the refrigerator. Lots 3, 4 and 5 in this first hatch were found wet with water in the refrigerator room. This probably is the reason none of the eggs in these lots hatched. There was no significant difference observed in the hatchability of the eggs held for one week under ordinary room conditions and those held in the refrigerator for the same length of time. If the results obtained from lot 3 in the first hatch are excluded, the eggs held in the refrigerator for two weeks hatched fairly well, the average hatchability of the second and third hatches being 40 per cent. The rather poor results obtained in lots 4 and 5 of the second and third hatches were expected, although slightly

higher percentages of hatchability were anticipated. The temperature in the refrigerator in which the eggs were held may have been too low. In this connection, Lippincott (1927) cited the results of the observations made by Mauro (1923) who reported that eggs that were kept for ten days at 0.5°C. showed no development when incubated, while of those held for the same length of time at 14°C., 60 per cent showed development. Lippincott remarked, however, that Mauro used a small number of eggs in his lots and evidently no control lots were used.

TABLE 2

*Showing the results of the three hatches in the second part of the first series.
Hatches were made in November, December and January*

LOT NO.	NUMBER OF EGGS IN LOT	TEMPERATURE	TIME IN REFRIGERATOR	HATCHABILITY			
				1st hatch	2nd hatch	3rd hatch	Average
		°C.	weeks	per cent	per cent	per cent	per cent
1	150	25—30	— ^a	52 ^b	46	58	52.0
2	150	8—12	1	46	44	70	53.3
3	150	8—12	2	42	44	38	41.3
4	150	8—12	3	14	12	10	12.0
5	150	8—12	4	8	10	4	7.3

^a Held for 1 week under ordinary room conditions.

^b From all eggs set. There were 50 eggs in each lot for each hatch.

Table 2 shows the hatching results obtained in the second set of the first series where the eggs were held in the refrigerator at a higher temperature. By reference to this table, it may be seen that the results obtained from the first three lots were essentially the same as those obtained from similar lots in the first series of hatches. Slightly better results, however, were obtained from the three hatches in the lot that was held in the refrigerator for four weeks under temperatures ranging from 8° to 12°C. than under temperatures ranging from 5° to 7°C. On the basis of his review of published literature on the subject combined with his practical experience, Lippincott concluded that a safe procedure would seem to be to keep eggs for hatching in a temperature between 50° and 60°F. (10.0° and 15.6°C.), if possible. The danger of keeping them too warm is probably greater than of keeping them too cool. It will probably be necessary, however, to make further tests in this regard before definite conclusions may be drawn.

TABLE 3

Showing the results of the three hatches in the second series. Hatches were made in April and May

LOT NO.	NUMBER OF EGGS IN LOT	TEMPERATURE	TIME IN REFRIGERATOR	HATCHABILITY			
				1st hatch	2nd hatch	3rd hatch	Average
		°C.	weeks	per cent	per cent	per cent	per cent
1	150	25—30	— ^a	2	4	2	2.7
2	150	6—11	2	28	56	34	39.3
3	150	25—30	— ^b	0	0	0	0
4	150	6—11	3	2	16	14	10.7
5	150	25—30	— ^c	0	0	0	0
6	150	6—11	4	2	4	2	2.7

^a Held for 2 weeks under ordinary room conditions.

^b Held for 3 weeks under ordinary room conditions.

^c Held for 4 weeks under ordinary room conditions.

The results obtained in the second series are given in table 3. Referring to this table it may be seen that the percentage of hatchability was significantly higher in lots 2, 4 and 6, which were kept in the refrigerator, than in those lots that were held under ordinary room conditions. These results corroborate those obtained by Philips (1909) who reported hatchabilities of 70.4, 43.1 and 0 per cent from eggs held for fourteen days at 50°F. (10°C.), 65°F. (18.3°C.) and 80°F. (26.7°C.), respectively. The very poor hatching results obtained in lot 1, held for two weeks under ordinary room temperature, were to be expected. These hatches were made during April and May, both of which are hot and dry months. Lamson and Kirkpatrick (1918) and Waite (1919) reported that under temperate conditions, two weeks may be considered the limit for holding eggs for hatching. But working under Los Baños conditions, Leoncio (1924) recommended that ten days may be considered the time limit for holding eggs in the months of low temperature, while in the hottest months of the year all eggs should be hatched while fresh.

Compared with the results of the three hatches in the second series those obtained in all the hatches in both the first and second parts of the first series, are fairly similar. No significant differences could be seen in the hatchability of the eggs held in the refrigerator for two weeks, three weeks or four weeks. The tendency in all cases was that the longer time the eggs were held in the refrigerator the lower the percentage of hatchability. But, as may be seen in table 3, none of the eggs that were held under ordinary room tem-

perature for three and four weeks hatched and of those held for two weeks, only 2.7 per cent hatched. These results seem to show that, although the percentage of hatchability may be low, hatching eggs may be held for incubation purposes for as long as four weeks under refrigerator temperature.

TABLE 4

Showing a summary of all hatches in both the first series and the second series of experiments

HOLDING PERIOD	HATCHABILITY		DIFFERENCE
	Room conditions	Refrigerator	
<i>weeks</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>
1	50.33 \pm 1.669	52.33 \pm 2.534	2.00 \pm 3.033
2	2.66 \pm 0.637	35.77 \pm 3.287	33.11 \pm 3.348
3	0.00	9.33 \pm 1.180	9.33 \pm 1.180
4	0.00	4.44 \pm 0.592	4.44 \pm 0.592

Table 4 gives the summary of the nine hatches in terms of average percentages. As shown in this table, the lot that was held for one week in the refrigerator gave slightly better hatchability, although not significant, than the control lot, the lot that was held for one week under ordinary room temperatures. The lot that was held for two weeks in the refrigerator had a very significantly better hatch than the lot that was held for two weeks under ordinary room conditions. The lots that were held under ordinary room conditions for both three and for four weeks resulted in no hatch, while there was a 9.33 per cent hatch in the lot that was held for three weeks in the refrigerator, and a hatch of 4.44 per cent in the lot that was held for four weeks.

SUMMARY OF CONCLUSIONS

1. There was no significant difference in the hatching power between the eggs that were held for one week under ordinary room conditions and those that were held for the same length of time in the refrigerator.

2. The eggs that were held for two weeks in the refrigerator hatched better than those that were held for two weeks under ordinary room conditions.

3. There were hatches from the eggs that were held three or four weeks in the refrigerator, but none from those that were held this length of time under ordinary room conditions.

4 The eggs that were placed in the refrigerator for 1, 2, 3, and 4 weeks hatched better than those that were held for the same periods under ordinary room condtions.

5. For the best results, two weeks may be considered a time limit for holding hatching eggs in low temperature.

6. It appears to be possible to keep eggs for hatching purposes from three to four weeks in low temperatures, although this may be recommended only in exceptional cases.

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A FUNGOUS DISEASE OF THE COCONUT LEAF MINER (*PROMECOTHECA CUMINGII* BALY)¹

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WITH TWO TEXT FIGURES

In January, 1930, a dead coconut leaf miner (*Promecotheca cumingii* Baly) which was pasted by a fungous growth on the under surface of a coconut pinna was found on one of the trees in the nursery of the College of Agriculture at Los Baños, Laguna, Philippine Islands (Celino, 1930). The fungous growth appeared almost white and chalky and it nearly covered the body of the insect. Microscopic examination of the powdery mass showed smooth, hyaline, septate mycelium and numerous smooth, small, spherical spores with olive buff ² contents.

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THE DISEASE

The fungous disease of *Promecotheca cumingii* has not been known hitherto in the Philippine Islands. Outside of the efforts of Reinking (1921) to enumerate the fungous diseases of economic insects no studies have been made of entomogenous fungi. Recently, Ocfemia (1931) reported the fungous parasites of *Pentalonia nigronervosa* Coq. and *Leucopholis irrorata* Chev. which were determined by Dr. T. Petch of Norfolk, England. In other countries, work on the entomogenous fungi receives considerable attention.

Jarvis (1924, 1925) reports a certain green muscardine fungus *Metarrhizium anisopliae* (Metsch.) Sor. which is parasitic on cane grubs in Australia.

This entomogenous fungus has been found on many insect hosts including beetles, grasshoppers and digger wasps.

¹ Experiment Station contribution No. 845. Prepared in the Department of Plant Pathology under the direction of Dr. G. O. Ocfemia. The writer is also indebted to Charles Fuller Baker Memorial Professor F. L. Stevens (Plant Pathology, 1930-1931) for suggestions, and for securing the opinion of Dr. Roland Thaxter of Harvard University as to the identity of the fungus.

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² The color nomenclature followed in these studies is that of Robert Ridgway. 1912. Color standards and color nomenclature. 43 p., 53 colored pl. Washington, D. C.

According to Gäumann and Dodge (1928), *Entomophthora muscae* Fressenius (*Empusa muscae* Cohn) has been reported by Brefeld, Thaxter and Olive as causing epidemics among flies.

Thaxter (1888) in his work on the Entomophthoreae of the United States reported twenty-four other entomogenous fungi on various insect hosts. In addition to these fungi, he mentioned over twelve other members of European *Empusa* which are parasitic on insects, but at that time not recorded in the United States.

Arnaud (1927) reported experimental cultures of *Beauveria bassiana*, *B. densa*, *B. globulifera*, and *Spicaria* sp. using caterpillars of the silk worm, *Bombyx mori*. In this report it is stated that infection without direct contact with the cultures was easily accomplished by dusting the spores either on the caterpillars or on their food. In general, it is stated that high humidity is favorable for infection but this situation is less favorable for the insect. This author further reports that under artificial cultural conditions *Beauveria bassiana* remains infective for more than two years.

Symptoms and signs

It is not easy to tell whether an insect is diseased or not. Infected coconut leaf miners, however, show signs of weakening. They seldom move or fly from one place to another. Very often they fall down sometimes dead, sometimes still alive. If still living, they may be seen lying on their back, the legs moving but no longer strong enough to carry the body. The surest indication of the presence of the disease is the appearance under humid conditions of the whitish, chalky fungous growth at the junction of the appendages at the anal opening and mouth parts of the affected insect (fig. 1a and b). From these places the fungus develops very fast, when favored by cool weather and moist atmosphere. The fungous growth almost completely covers the body of the insect in a few days. When the body of the host is dissected and the parts examined under the microscope, mycelium and spores of the parasite are always found associated with the tissues of the insect body.

In advanced cases of infection, the internal organs of the host practically disappear and a thick mass of fungous materials may be seen instead. When favored by environmental conditions, the parasite grows very fast, and some of the infected leaf miners may be seen pasted to the coconut leaves by the fungous growth. Infected insects do not disintegrate, they become dry and hard.

THE FUNGOUS PARASITE

Morphology

Mycelium. The fungus does not produce an abundance of aërial mycelium under field conditions or on artificial culture media. Old cultures on synthetic agar, corn meal, and potato cylinder develop a thin coating of whitish aërial hyphae. The mycelium is usually smooth hyaline with sea-foam green content, conspicuously branched and easily broken. The end of the mycelium is bluntly rounded, granular, sometimes empty when old, and often markedly character-



Fig. 1.—(a) Four adult leaf miners *Promecotheca cumingii* Baly photographed to show the fungous growth on the body, mouth parts, and appendages as shown by the dorsal and ventral views. $\times 9/10$. (b) Four adult leaf miners photographed and enlarged to show the fungous growth on the ventral and dorsal sides of the insects. $\times 2\frac{1}{3}$. (Photograph by the Photographic Division, Department of Soils, College of Agriculture.)

ized by numerous irregular hyphal swellings. Petch (1926, p. 251) gives Picard's characterization of the mycelium of *B. bassiana* as mealy or chalky. Anastomosis of hyphae is very common. The hyphae are very closely septate and the cells vary from 6.3 to 29.3μ in length and from 2 to 4.5μ in width.

Types of spores produced. The parasites produce numerous small spherical spores with olive buff content. They vary in size from 2.1 to 3.2μ in diameter. In Petch's *Notes on Beauveria* (1926;

p. 249) the conidia of *B. bassiana* are given as globose $2.5\text{--}2.8\mu$ (de Bary); $2\text{--}2.5\mu$ (Delacr.) In hanging drop preparations of sterile water, nutrient broth, water with small amount of sugar and potato dextrose agar, the fungus occasionally produces some larger short ovoid to nearly rod-shaped spores. They have a smooth surface, thin buckthorn brown cell wall and sea-foam green to pale glass green protoplasmic content, and vary in measurements from 6.3 to 12.4μ in length and from 2.7 to 3.3μ in width.

Conidiophores. The conidiophores are hyaline, aërial, usually not long, non-septate, nearly perpendicular to the mycelium, narrow at the base, wide at the middle and very narrow at the distal end. They vary in measurement from 1.4 to 2.6μ in width. On their ends are borne the microconidia, usually from one to 12 spores on one conidiophore.

Germination of spores and spore-formation in culture. A few days after they are formed, the spores germinate readily in a small amount of water. In hanging drop preparations of sterile water, nutrient broth, water with a small amount of sugar and on some agar culture media, spores from cultures germinate within 24 to 48 hours. Preparatory to germination the spores absorb water and increase in diameter. A germinating spore sends out a germ tube or several of them. The germ tube or the hypha of germination (Thaxter, 1888) either elongates and produces branching hyphae or swells at the tip and forms a small secondary spore. A few short ovoid to nearly rod-shaped conidia sometimes develop along the sides as lateral outgrowths. In this way the hyphae of germination becomes a simple conidiophore. Very frequently the conidiophore arises from the mycelium as lateral aërial growth and at its end are formed from one to 12 spores. This conidiophore differs from those of the entomogenous Entomophthoraceae, as the latter, besides showing considerable external branching, are arranged in a corymbose or digitate fashion (Thaxter 1888).

Cultural characters

The behavior of the fungus on various artificial culture media was studied and the results of the study are as follows:

1. *Water agar (20 days old culture).* The growth was very poor. It was characterized by only a few small white patches of powdery fungous growth on the surface of the slant. Even after two months, practically no progress in growth was shown.

2. *Potato dextrose agar (24 days old culture)*. The growth was quite slow, thin, concentric, powdery, slightly raised with scanty aërial hyphae. In general, the color of the fungous growth was olive yellow to pale pinkish buff.

3. *Nutrient beef agar (24 days old culture)*. The growth was generally slow, thin, concentric at the beginning, powdery, with sparse, aërial, pale white mycelium. The color of the growth was neutral gray with pale white and tilleul buff scattered masses of mycelium and spores.

4. *Potato-dextrose-leaf-miner extract*³ *agar (36 days old culture)*. The growth was gradual, powdery, fairly thick, slightly raised, very scanty aërial hyphae which was pinkish buff with small pale white scattered patches of fungous growth.

5. *Cane juice peptone water agar (23 days old)*. The growth was slow, but thick, concentric, powdery, pale pinkish buff with narrow pale white borders. The agar medium was slightly depressed.

6. *Synthetic agar (25 days old)*. The growth was very fast, very thick, and powdery. Usually particles of moisture gathered on the surface. An abundance of aërial hyphae, with concentric rings not clearly differentiated was produced. The growth was pale olive buff to pale pinkish in color. A rapid growth continued even after one and one-half months.

7. *Potato cylinders (36 days old)*. The growth was slow, powdery, thin with very scanty aërial hyphae. Tufts of white mass of hyphae very much raised, more or less rounded, about five mm. or more in diameter, were found on the surface of 36 days old culture. The color was marguerite yellow to pale pinkish buff.

8. *Steamed rice (35 days old culture)*. The growth was slow, producing powdery, scanty aërial hyphae, which were olive to marguerite yellow in color.

9. *Corn meal (21 days old)*. The growth was fairly fast, thick, powdery, with fairly abundant white to pale white aërial mycelium. The growth continued in culture more than one month old.

10. *Oatmeal agar (36 days old culture)*. A slow growth, consisting of powdery, thin, scanty aërial hyphae of pale white color.

³ About 250 coconut leaf miners were boiled for some time in 500 cc. of distilled water. The liquid was filtered and the extract (500 cc.) was added to a preparation of potato dextrose agar (500 cc. water, 200 grams potato, 20 grams agar and 20 grams dextrose) so that the mixture was 1000 cc. or 1 liter preparation of potato dextrose and leaf miner extract agar.

11. *Oatmeal agar + 2 per cent dextrose (36 days old)*. The growth was practically the same as that on oatmeal agar.

12. *Corn meal agar (20 days old)*. The growth was slow, not powdery as the fungous growth on other culture media. The fungus produced but scanty aërial hyphae.

Pathogenicity

Laboratory experiments. On January 31, 1930, trial experiments with the suspected fungous parasite were performed in the laboratory of the Department of Plant Pathology. Some fresh mature coconut leaves placed in two small beakers that contained a small amount of water were placed inside two large bell jars. One hundred recently caught coconut leaf miners were freed inside each bell jar. The insects inside one of the bell jars were inoculated by spraying them with the spores of the fungus suspended in sterile water. Those in the other bell jar were sprayed with sterile water only. These insects served as the control. The mouths of the containers were covered with cheese cloth; both jars were kept under observation in the laboratory. After two days there were 32 dead insects among those inoculated and 6 dead in the control. Actual counts of the dead insects on the afternoon of the third day gave 77 per cent mortality among the inoculated and 13 per cent in the control, the difference being 64 per cent. After six days, not one of the inoculated insects was alive while only 25 per cent of the control were dead. The dead insects were collected and placed in two separate damp chambers. After three days, it was noted that a white and chalky fungous growth developed on the bodies of the dead inoculated insects. No fungous growth developed on the dead insects of the control. From the result of the first experiment it was inferred that the high percentage of mortality of the inoculated insects was due to the attack of the fungus. The cause of the death of 25 per cent of the insects in the control was probably due to confinement in the damp chamber. The organism was reisolated and pure culture of it was obtained. Comparison with the original culture of the fungus showed no difference so far as the mycelium, spores, and growth of both cultures were concerned.

Inoculation was repeated on February 17, following the same method and using the cultures from the reisolation of the organism. In this second trial two sets of inoculations were made and after six days these gave 90 and 93 per cent mortality of the leaf miner

in the inoculated lot and 48 and 49 per cent mortality of the insects in the control. The difference of the averages of deaths was 43 per cent.

Another inoculation experiment was performed on February 28; the coconut leaves were sprayed with the spores of the fungus suspended in sterile water before allowing the insects to alight and crawl on the wet leaves. After six days, 88 per cent of mortality of the insects on the inoculated leaves and 30 per cent of those in the control were noted. The results of the inoculation experiments showed that the cause of the death of from 43 to 58 per cent of the inoculated insects was the fungous disease.

Taxonomy

On June 11, 1930 infected adults of *Promecotheca cumingii* Baly which were collected by the writer on coconut pinnae at the College of Agriculture were sent by Dr. G. O. Ocfemia to Dr. T. Petch of Norfolk, England for identification. In a letter to Doctor Ocfemia under date of August 12, 1930, Doctor Petch states that the fungus on the leaf miner is *Beauveria bassiana* (Bals.) Vuill.

Dr. F. L. Stevens, Charles Fuller Baker Memorial Professor of Plant Pathology (June 22, 1930 to February 22, 1931) sent to Dr. Roland Thaxter of Harvard University, cultures, temporary mounts, and drawings of the Philippine leaf-miner fungus. In a letter to Doctor Stevens dated January 4, 1931, Doctor Thaxter also states that the fungus seems to be *Beauveria bassiana*. Doctor Thaxter further states that "It is the old silkworm disease of Europe that attacks insects of many orders all over the world apparently."

Method of infection

Infection takes place by contact of the fungous spores with the insect body. The spores which seem to be coated with a sticky substance easily adhere to the body of the insect host and when the conditions of the weather become favorable for their development they germinate readily by sending out germ tubes or hyphae of germination. These germ tubes enter the body of the insect possibly through the sutures of the joints of the appendages, and through the mouth and anal openings. Inside the body of the insect the fungus produces fruiting structures very profusely. The mycelium invades the softer tissues of the host and forms numerous spores. After two to three days the insects fall down and later die. Microscopic examination of

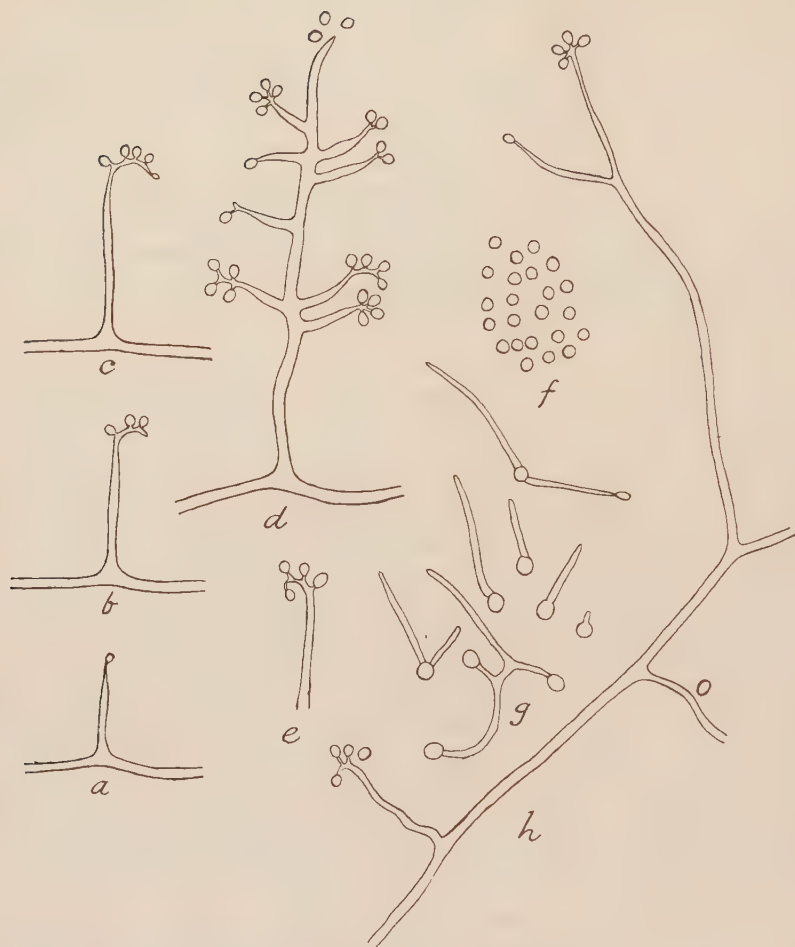


Fig. 2.—The fungous parasite *Beauveria bassiana* (Bals.) Vuill. of *Promecotheca cumingii* Baly showing: (a) A young conidiophore with a developing spore in hanging drop preparation of potato dextrose agar, 2 days old culture. (b) The same conidiophore 20 hours later. (c) The same conidiophore after 30 hours more. (d) Portion of a hypha showing how the conidiophores are borne. Grown in potato dextrose agar 5 days old. (e) A conidiophore bearing a large short ovoid spore. (f) Some spherical mature spores. (g) Germinating spores in hanging drop preparation of nutrient broth 24 hours old. (h) Portion of a hypha in hanging drop preparation of nutrient broth 5 days old. All camera lucida drawings, using Reichert microscope with a 13× ocular and 4 mm. objective. About 163×.

the body of the affected insect showed the presence of an abundance of almost spherical to short ovoid spores and pale greenish hyphae associated with the tissues. The spores and the hyphae soon fill the body of the insects; most probably they clog the breathing pores or spiracles and consequently the host dies. This is what happens in the case of *Entomophthora empusa* which parasitizes and causes the epidemics on flies (Gäumann and Dodge, 1928).

Pathological anatomy

Bodies of dead insects were dissected and examined under the microscope. An abundance of fungous spores and mycelium were found among the tissues of the insect body. In some instances, the body of the host was found almost empty, the tissues having been used up by the parasite. The appendages were dissected and the tissues in them were likewise found seriously invaded by the fungus. The chitinous materials of the insect body appears to be resistant to the attack. Development of the fungus practically ceases after all the softer tissues in the body are consumed.

SUMMARY

1. The fungus *Beauveria bassiana* (Bals.) Vuill. is parasitic on the coconut leaf miner (*Promecotheca cumingii* Baly) in the Philippines. This entomogenous fungus under the laboratory conditions, causes from 43 to 58 per cent of mortality of the insect hosts.

2. Insects infected with the disease show whitish, chalky fungous growth at the junction of the appendages, at the anal opening and the mouth parts.

3. The fungus is characterized by white or pale and chalky growth in cultures and by producing smooth, fine, closely septate vegetative hyphae and abundant small spherical spores which measure from 2.1 to 3.2 μ in diameter. In hanging drop preparations larger spores which are short, ovoid to nearly rod-shaped are occasionally produced. These spores vary in measurement from 6.3 to 12.4 μ in length and from 2.7 to 3.3 μ in width.

4. The conidia germinate readily in water and in other culture media.

5. The fungus grows very well on synthetic agar. Fairly good growth is also shown on corn meal and on potato-dextrose-leaf-miner extract agar.

6. Infection takes place when the spores come in contact with the body of the insect host. The conidia germinate and the germ tubes gain entrance into the insect body probably through the sutures of the joints of the appendages, and probably also through the mouth and anal openings.

7. Inside the body of the host, the fungus produces numerous spores. These spores and the mycelium probably clog the breathing pores of the insect. The affected insect dies after two to three days.

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TOP WORKING OLD COFFEE TREES WHICH ARE POOR YIELDERS¹

CLARO C. BAGALSO

WITH FIVE TEXT FIGURES

INTRODUCTION

One of the methods by which coffee culture may be improved is the multiplication of good yielding mother trees by grafting. While it is true that coffee trees can be propagated by seed several hundred times faster and easier than by grafting still, in certain cases on modern coffee plantations, grafting is the method advisable to use.

Various methods have been resorted to in an effort to bring about the maximum output of quality coffee. Years of experimental endeavor have been spent and men of technical training have worked for the improvement of coffee cultivation. These men have concluded that grafting, in spite of its difficulties, is the most satisfactory method of propagating coffee plants vegetatively.

Top working is one of the methods employed in some countries to improve coffee trees which are poor yielders. Java, one of the leading countries in coffee production, has adopted this method in the rejuvenation of old coffee plantations. The results have been encouraging.

According to Cramer (1923) old coffee trees which are not paying for their upkeep are made profitable by top working. Trees which are poor yielders are changed to good yielders, and above all an even stand of the trees in the plantation and products of uniform quality are obtained in a rejuvenated plantation.

So far as the author knows, no study on top working coffee trees has heretofore been conducted in the Philippines.

Review of literature

Regarding the height of topping, Preyer and Zimmerman (1901) state that old trees should be cut off three feet from the ground leaving the strongest shoot for grafting. Wester (1922) claims that

¹ Thesis presented for graduation, 1931, with the degree of Bachelor of Science in Agriculture from the College of Agriculture No. 334; Experiment Station contribution No. 846. Prepared in the Department of Agronomy under the direction of Dr. Nemesio B. Mendiola and Mr. Jose C. Ramos.

top working was first employed on seedlings on the plantation and shoots arising from the stocks were either shield budded or cleft grafted. The same investigator (1920) reported that the age and appearance of the stock is unimportant, but to produce normal trees the scions should be made from the stem, never from the branches.

Cramer (1923) found that the best stocks for grafting were Liberian and Excelsa varieties. He contended that "the stocks certainly play an important part and that in some varieties, for example, scions of a certain definite Robusta parent grafted on Excelsa stock succeeds with difficulty, whilst the same on stock of a Robusta type easily splice and flourish." Cramer emphasized, however, that this is not always the case, because a certain Robusta No. 105 used as source of scion on stock of Robusta type gave unsatisfactory results. Mendiola (1928) reports that in Java when old stumps are used as stocks, four water sprouts are grafted at the same time, later, only the best one is left to develop.

The work of Romero (1930) in the multiplication of selected trees by grafting on seedling stocks is noteworthy. In connection with the technique of grafting, he found that during the rainy season the glass tube proved to be an efficient covering for the grafts; while during the dry season banana leaf petiole and sphagnum moss proved to be the best. The findings of Romero (1930) corroborated the statement of Wester (1920) that scions obtained from the main stem grow normally, while scions from the lateral branches grow in only one direction.

Object of the present work

The object of the present work was: To find out whether it is possible to recondition, by top working, the old, poor yielding coffee trees in the College of Agriculture Coffee Plantations.

Time and place

This work was conducted in the Plateau Coffee Plantation of the Department of Agronomy, College of Agriculture, Los Baños, Laguna from November 1929 to January 1931.

MATERIALS AND METHODS

Materials and tools

A pair of sharp pruning shears and a good blade grafting knife were used in this experiment. For securing a tight-fitting-contact of the cambium layers of both the scions and the stocks of the grafts,

twine was used. To prepare the grafting tape, the same materials and formula used by Romero (1930) were employed, that is, several strips of ordinary cheap white cloth, each rolled on a short stick, were dipped in a melted mixture containing by weight, one part of tallow, two parts resin and four parts beeswax. No grafting wax was used; grafting tape was used instead.

Trees on the Plateau Coffee Plantation of the College which were reported by Romero (1930) as heavy yielders and which are also found in the record book of the individual coffee trees in the Department of Agronomy were used as sources of scions.

About 200 Robusta trees on the College Plateau Coffee Plantation which were found to be old and poor yielders were selected as stocks. These trees were planted in 1916 at an elevation of 100 meters above sea level, as reported by David (1928). A sharp pruning saw was used in pruning the trees. Coal tar was used in painting the wounds of the topped coffee trees.

The materials used for covering the grafts were: sphagnum moss, banana leaf petiole, and glass tubes.

Procedure

The coffee trees which were found to be poor yielders were used as stocks. They were topped at a height varying from 60 to 90 centimeters above the ground, depending upon the condition of the trees. Smaller trees were topped higher on the basis that they can not resist heavy topping as well as the larger trees. After topping each tree, the hectare in which the tree is planted, the hill number, and the date when topping was done were recorded. All cut portions of the topped trees were painted with coal tar as protection.



Fig. 1.—Appearance of a poor coffee tree before topping.

From the time of topping, records of the date when the water-sprouts emerged were made. At least three or four water-sprouts were allowed to grow on each tree after topping; the others were removed as soon as they arose from the main stem. The object of allowing only a few water-sprouts to grow was to make them strong and vigorous.



Fig. 2.—The same tree as in figure 1, after topping.

Only cleft grafting was used in this work. As soon as the water-sprouts became ready for grafting they were cleft grafted. Before the grafts were tied and covered the diameter of the stock and of the scion was measured with the use of a micrometer caliper. Both old and young scions were used in grafting. Scions which showed marked development of the woody portions in the stem were classified as old scions while those which did not exhibit woody portion in the stem were classified as young scions. Scions were taken only from the main stem, never from the lateral branches.

Three kinds of materials were used in covering the grafts: glass tube, sphagnum moss, and banana leaf petiole. The same process followed by Romero (1930) was followed in covering the grafts. If the banana leaf petioles dried up they were changed for fresh ones. The sphagnum moss was moistened with water whenever it showed



Fig. 3.—A coffee tree with water-sprouts ready for grafting.

signs of drying. After three weeks all the covering materials were removed. Water-sprouts arising from the main stem, other than the sprouts intended for grafting, were not allowed to develop.

To give a clearer idea of how the work was performed, photographs of some trees before and after the operation were taken.

EXPERIMENT AND RESULTS

The total number of coffee trees topped was 209. Out of this number only 137 were grafted. Only *Coffea robusta* Linden was used both as stock and scion in this experiment.

Tables 1 to 3 and figures 1 to 5 show the results of this work.

Table 1 gives the relation of the kind of covering to the success of the work. The percentage of success obtained for each kind of covering was as follows: glass tube, 30.8; no covering, 21.8; sphagnum moss, 8.4; and banana leaf petiole, 4.8.

Table 2 shows the relation of the size and age of the scion and the stock to the percentage of success. Stocks with an age of 300 days or more gave the best results. The size of the stock did not appear to have any direct relation to the success of the work. Old scions gave an average percentage of success of 37.8; the young scion, 14.1.

Table 3 shows the summary of results, or the percentage of success obtained in each month. The highest was obtained in January with an average of 55.3 per cent; the next highest, 27.5 per cent in December; October was the lowest with 26.0 per cent.

DISCUSSION OF RESULTS

Number of trees topped, days from pruning to emergence of water-sprouts, date when grafted, and effect of the covering materials on the grafts

It has been pointed out that out of 209 coffee trees topped, only 137 trees were grafted. This was because some of the trees produced water-sprouts which were too small to be grafted; while other trees died in the course of the experiment. Shoots arising from the main stem of an individual tree usually emerged at the same time. A typical example of a coffee tree before topping is shown in figure 1. It will be noted that some of the branches are defoliated and the uppermost part of the main stem is almost dead. This tree was a very poor yielder. The same tree after topping is shown in figure 2. In figure 3 is shown a typical tree after topping with three vigorous water-sprouts ready for grafting. In figure 4 is shown another tree with four water-sprouts already grafted and covered. A typical example of water-sprouts with living grafts is shown in figure 5. It will be noted that the water-sprouts grafted are stocky and the living grafts are vigorous.

In this experiment it was found that the number of days necessary for the water-sprout to emerge varied from 18 to 49 days. This means an average of about four weeks. This result coincides practically with the finding of Gonzales Rios (1929) who reported that after topping the trees, the water-sprouts began to emerge in from three to four weeks. The age at which the water sprouts became ready for grafting varied from 115 to 381 days. The wide range of variation seems to be due entirely to the vigor of the individual tree. The more vigorous trees produced water-sprouts earlier than those trees which were in poor condition. Furthermore, the poorer trees produced slender water-sprouts, which, according to observation, required a much longer time to reach the grafting age.

In the present investigation, it was found that grafts which were covered with either banana leaf petiole or sphagnum moss gave a poor result during the rainy months, from July to January. This is in accord with the findings of Romero (1930).

As shown in table 1, glass tube covering gave an average of 30.8 per cent, no covering, 21.8 per cent, sphagnum moss, 8.4 per cent, and banana leaf petiole, 4.8 per cent. It should be mentioned that in the present work no determination of the efficiency of the different covering materials was made for each month.

The relation of the size and age of scion and stock to the success of the work

In order to find out the relation of the size and age of scion and stock to the success of the work, the percentages of success obtained for each month were determined both for the young and the old scions.

Table 2 shows the number of grafts made in each month, using two kinds of scions, with the corresponding percentages of success obtained. The size of the scion and the stock does not seem to have any direct relation to the success of grafting. Scions of practically the same average size which were grafted on stocks of about the same size gave variable percentages of success. This result was true in each month. As, for example, in the case of young scions, during October the average diameter of the scion was 6.7 mm. and of the stock, 8.4 mm. while the percentage of success was 11.4; in December the average diameter of the scion was 6.7 mm. and of the stock, 8.4 mm. while the percentage of success, was 22.2; in January the average diameter of scion was 6.5 mm. and of the stock, 8.3 mm.; the percentage of success was 46.2. The same result was true with the old scions.

On the other hand, the age of the scion, as shown in table 2, has some direct relation to the success of grafting. The young scions, on the whole, gave an average of 14.1 per cent success while the old scions gave 37.8 per cent success which is more than twice the percentage obtained with the young scions. The reason for this difference is probably that in many cases young scions dry up before

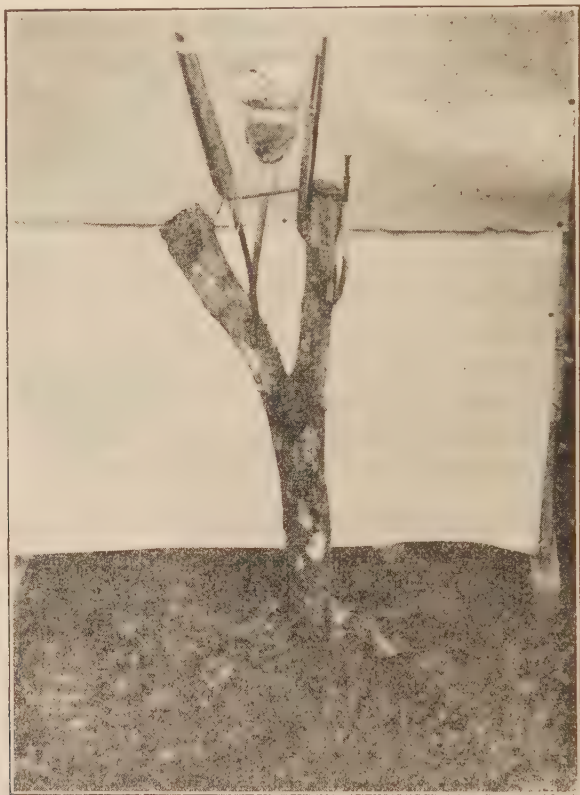


Fig. 4.—An example of a coffee tree just after grafting.

union takes place, while old scions can stand drying longer, probably because of better development of cork cells. Consequently, there is a better chance for the stock and old scion to callus and unite.

The results of the present investigation seem to show, however, that the older stocks gave better results than the younger. It will be noted in table 2 that, in general, stocks with an average of 300 days or more gave the higher percentage of success. In some cases where the differences in age was only a matter of a few days no marked differences in the percentage of success was noted.

Comparisons of results obtained in different months

The percentage of success obtained for each month is shown in table 3. That only a few trees became ready for grafting in some months and many in other months, accounts for the uneven distribution of the grafts as to time. Another reason is that some of the water-sprouts grafted in the earlier months did not grow, so they were regrafted, later. The highest percentage of success, 55.3, was obtained in January. December gave 27.5 per cent success and October, 26.0 per cent. The percentages of success obtained in other months are as follows: August, 15.1; November, 11.8; July, 10.0; and September, zero.

Factors which contributed difficulties in the work

In carrying out the work several difficulties were met. Some of them were as follows:

Training in grafting. This is probably one of the factors which has a direct relation to the success of the work. One who has had no past training in grafting will get a low percentage of success at the beginning. Only through constant practice can skill in the art of grafting be acquired.

Vigor of the water-sprouts. In the majority of cases it was observed that grafting on the less vigorous water-sprouts seldom succeeded. It was also noted that some trees after topping produced water-sprouts which were so small that they could not be grafted at all. Some of the trees which were topped fell under the category "not grafted".



Fig. 5.—An example of a coffee tree with living grafts.

The effect of anay, Macrotermes gilvus Hagen. In some cases *anay* built a mound of soil at the base of the tree and before they were observed they had done some damage to the trees. This damage was most serious in grafted water-sprouts because the *anay* covered the whole graft with soil and ate up the base of the insertion, giving no chance for the grafts to callus and live. In some cases the living grafts were destroyed. This *anay* damage accounts, in part, for the small percentage of success obtained in this work.

Falling branches of shade trees. The coffee trees which were used in this experiment are provided with shade trees, *madre de cacao*, *Gliricidia sepium* (Jacq.) Steud. The dry branches of these shade trees when they fell off sometimes hit the grafts and broke them.

SUMMARY OF CONCLUSIONS

1. It was found that not all coffee trees could be top-worked. Some trees produced water-sprouts which were too small to be grafted.
2. Glass tubes proved to be the best covering material, no covering was second, sphagnum moss, third, and banana leaf petiole, fourth.
3. Old scions gave a higher percentage of success than young scions.
4. The time from topping to emergence of water-sprouts varied from 18 to 49 days.
5. In general, the water-sprouts became ready for grafting in about 250 days.
6. The size of neither the stock nor the scion had any direct relation to the success of grafting.
7. The comparatively high percentages of success were obtained in January, December, and October.
8. In this work the total number of trees topped was 209, of which only 137 were grafted; only 61 have living grafts.

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TABLE 1

*The relation of the kind of covering to the success
of the work*

COVERING	NUMBER OF SCIONS INSERTED	PERCENTAGE OF SUCCESS
Glass tube	154	30.8
Banana leaf petiole	79	4.8
Sphagnum moss	34	8.4
No covering	162	21.8

TABLE 2
The relation of the size and age of scion and stock to the success of top working

MONTHS	STOCK			YOUNG SCION			STOCK			OLD SCION		
	Average age	Average diameter		Average diameter	Number of scions inserted	Percentage of success	Average age	Average diameter		Average diameter	Number of scions inserted	Percentage of success
1930	<i>days</i>	<i>mm.</i>		<i>mm.</i>			<i>days</i>	<i>mm.</i>		<i>mm.</i>		
July	218.0	8.7		6.4	10	10.0	—	—		—	—	—
" August	207.7	8.5		7.2	52	1.8	251.5	8.7		6.9	34	35.2
" September	217.2	8.3		6.8	10	0	—	—		—	—	—
" October	197.7	8.4		6.7	35	11.4	201.9	8.9		6.8	38	39.4
" November	247.7	9.5		6.9	44	6.8	205.2	9.1		7.3	49	16.3
" December	301.2	8.4		6.7	72	22.2	310.3	9.1		7.1	37	38.1
1931 January	311.7	8.3		6.5	13	46.2	319.7	9.0		7.4	25	60.0
Average	242.9	8.6		6.7	—	14.1	257.5	8.9		7.1	—	37.8

TABLE 3
Summary of results

MONTHS		NUMBER OF SCIONS INSERTED	PERCENTAGE OF SUCCESS
1930	July	10	10.0
"	August	86	15.1
"	September	10	0
"	October	73	26.0
"	November	93	11.8
"	December	109	27.5
1931	January	38	55.3

Total number of trees topped	209
Total number of trees not grafted	62
{ Some died and others produced water-sprouts } which were too small	
Total number of trees grafted	137
Total number of trees with living grafts	61
Percentage of successful trees grafted	44.5

ABSTRACT ¹

A study of vegetative buds of *Hevea brasiliensis* (HBK.) Muell.
—Arg. from the standpoint of propagation by budding. BUENAVENTURA M. AGUANTA. (*Thesis presented for graduation, 1929, with the degree of Bachelor of Science in Agriculture, from the College of Agriculture, No. 335; Experiment Station contribution No. 847*)—— The vegetative buds of *Hevea brasiliensis* were studied from the standpoint of propagation by budding and the determination of the number and readiness of separation of buds in different parts of a tree, also the adaptability of these buds to budding work. Several budding methods were first tried, to determine which could be applied in this study. Patch budding and, to certain extent, shield budding were used. The results obtained by the author are summarized as follows:

1. Under Los Baños conditions, September, October, November, and May are the best months for rubber budding.

2. The patch budding method was found best adapted to the propagation of rubber by budding. Shield budding may also be used but further trials should be made before any conclusion as to its adaptability can be drawn.

3. Undeveloped but vigorous buds which are still green are the most desirable.

4. The production of budwood can be induced by pruning the trees. In from six to eight months after pruning, budsticks are again obtainable.

5. Vigorous and plump stocks are always preferable because the bark separates easily from the wood at the cambium layer. If the bark of the stock does not slip readily from the wood at the cambium layer, the percentage of failure of union is very high.

—Abstract by Lorenzo N. Talatala

¹ Abstract prepared as part of required work in English 3a, College of Agriculture.

CURRENT NOTES

A close study of the various factors affecting the rice-growing industry in Italy in of more than passing interest to Malaya. Not only is the production of rice of considerable importance in Italy, but the average yields are the second highest recorded in the world. Whereas in Malaya, the average yield of padi per acre is 0.52 ton, in Italy the average yield is 1.87 tons per acre. If it were possible to increase the Malayan yields to the Italian standard, this country would be self-supporting in the matter of rice production without any addition to the existing planted area....

The application of the Italian system to Malayan rice production—if it was possible in all respects and is assumed to be equally productive—would show a decided decrease in the cost of production in comparison with the present cost in the respective countries.

The success of the Italian system may be summarised as being due to efficient water control, rotation of crops, thorough cultivation, heavy manuring, adequate scientific advice, heavy-yielding varieties of padi and the existence of an intelligent and industrious agricultural population.

The notable difference between this system and the Malayan system is rotation of crops and heavy manuring.

The Malayan Agricultural Journal, June, 1932

Blood, as it comes from the animal, is of value as a fertiliser, since it contains about 1 1/4 per cent. nitrogen. When put on the market as a fertiliser, blood is first dried and then finely ground to powder. This dried blood contains 11 per cent. nitrogen, and is quoted on the Sydney market at £11 per ton.

Blood and bone fertiliser is a mixture of dried blood and crushed bones. Its market value is about £7 per ton, and it contains 4 to 7 per cent. nitrogen and 10 to 17 per cent. phosphoric acid.

In order to manufacture a marketable fertiliser from blood, bones or animal offal, costly plant and machinery for drying, grinding, etc., are required. Blood and bones could be made into a manure for local use in the following simple manner:—

If liquid, the blood should be absorbed in sawdust, earth or litter; if solid, the clotted mass should be mixed with a loamy soil and forked over. The material containing the blood is then mixed with more soil and made into a compost heap in the same way as stable manure is composted. If bones are available they should be steamed

to remove the tallow and then ground. If it is not practical to do this, then the bones could be broken up with a sledge hammer and added to the heap along with a couple of bucketsful of wood ashes. More soil should then be added and the heap kept damp, forked over, and allowed to remain for a couple of weeks, or until the material is well decomposed.

At the end of this time the compost should be spread on the land and well dug in. Such material should be a good manure, as it supplies both nitrogen and phosphates to the soil.

Agricultural Gazette of N. S. W., September 1, 1932

Diversification products increased, particularly in coffee and fruit trees, though it is evident that if we want more rapid progress in diversification, large scale planting is necessary.

The diversified crops that are gaining ground, besides coffee and citrus, are kapok, lumbang, and particularly pineapples because of the extensive planting undertaken by a local company in Mindanao.

Commerce and Industry Journal, Philippines, April, 1932

Overseas authorities have recently recommended superphosphate as an absorbent, deodorant, and conserver of nitrogen in stables. The scattering of superphosphate in the stalls and gutters of horse-stables and cow-sheds has for its objects the removal of objectionable odours and the absorption and fixing of ammonia in the manure. Any one accustomed to enter a horse-stable in the early morning is familiar with the pungent odour which assails his nostrils—proof that valuable ammonia is being lost by volatilization.

The use of superphosphate for the purpose mentioned is very rational, as this particular fertilizer contains a considerable proportion of gypsum (hydrated sulphate of lime). It is a well-known agricultural fact that gypsum in a finely divided state is specially adapted as a preservative agent of the fertilizing principles of farm-yard manure.

Superphosphate should not only prevent the loss of ammonia but also add phosphoric acid plant-food, in which farmyard manure is somewhat deficient. The ammoniation of superphosphate is a process recently introduced by the fertilizer industry, whereby ammonia liquor is added to and absorbed by superphosphate, which fixes the ammonia (or nitrogen) in a chemical compound. The same principle is held to apply to the use of superphosphate as an ammonia absorbent in stables.

The New Zealand Journal of Agriculture, July 20, 1931

Unquestionably it will take more labour to produce fifty bushels from an acre than it will to produce ten bushels from the same acre; but will it take more labour to produce fifty bushels from one acre than from five?

The Agricultural Gazette, New South Wales, March, 1932.

Like a dog digging for a bone, a remarkable "rotary plow" demonstrated recently in England throws a stream of pulverized earth into the air behind it. The business end of this new aid to farmers is a revolving cultivator geared to the motor of its tractor frame. As the machine travels across a field, it plows the soil, pulverizes it, aerates it, and cuts any surface growth to pieces, all in one labor-saving operation, thus making unnecessary the use of a tooth drag or a disk harrow.

Popular Science, May 1932

COLLEGE AND ALUMNI NOTES

Governor General Roosevelt was the guest of honor on Loyalty Day.

Dr. David S. Hibbard, President Emeritus of Silliman Institute was Convocation speaker on September 27. He spoke upon problems which his generation was passing on to the coming generation in the Philippines to solve. The five problems which he discussed as the most important were: Labor and its position and relation with capital; international relations, or preserving world peace; concentration in thought and production; English language in the Philippines; and woman suffrage:

Excerpt from *Tropical Life*, August, 1932.

Dr. Edwin B. Copeland, an old time "Friend" of this journal, founder and first Dean of the College of Agriculture at Los Baños, returned (on leave from the University of California) to the Philippines as Agricultural Adviser in the Bureau of Plant Industry. The College went *en fete* at his arrival. First there was a luncheon at which eighteen oldtimers were guests. Later, those of "Copeland's time" and others offered him a welcoming dinner at which a hundred and more sat down, some with experience of the College and its work away back to the start in 1909. Dr. Copeland was found to have changed but little; perhaps a few more white flakes in his hair since 1917, when he left, we believe to encourage and push on the cultivation of rice in the Mississippi Valley during the war. Altogether the

College and the Campus had a good time and by now the students are working more diligently than ever with the first Dean in their midst again. These festivities must have been taking place about the time that the third edition of Dr. Copeland's book "The Coconut," made its appearance in London, through the firm of Macmillan; see our two reviews in the February and March issues.

Doctor Copeland gave the second of his series of lectures on Practical Ethics on September 27, in the afternoon.

The following note is from *Tropical Life*, August, 1932.

THE PHILIPPINE AGRICULTURIST for June (published by the College of Agriculture, out there) has a very good article, illustrated, on goat raising. One illustration shows an Anglo-Nubian grade of doe, whose last milking period gave 166 litres in 241 days; another shows a proper method for killing a goat. The animal is laid on its side with the man's right knee on its shoulder whilst his left hand appears to be holding the animal firmly about the nose and mouth. In his right hand he has a long knife which is quickly thrust through a point at the back of the lower jaw with the blade directed towards the ventral side of the animal so that at one stroke the blood-vessels and tissues are cut, causing instant death.

Loyalty Day, October 10, was observed with the usual enthusiasm. The great feature of the day was the use of Baker Memorial Hall for the program. True, the Hall has no windows, no seats, but it offers the comfort of shelter from sun and rain. From the balcony, Governor General Roosevelt, President Palma and other officials reviewed the Student Parade. The float of the Sugar Technology Class was the most original. The motif was that Hare-Hawes-Cutting Congressional bills would strangle Philippine industry. It was graphically and forcibly presented.

The program was in Baker Hall. President Palma introduced Governor General Roosevelt. In his address, His Excellency laid special emphasis on the loyalty of citizens in times of peace. Too many citizens ask. "What can I get from the government, not what can I do for the government." "If, make the world safe for democracy is to be our slogan, democracy must be made safe for mankind."

The afternoon was given up to Cadet field athletics.

In the evening the Mimics presented the popular and well-loved Gilbert and Sullivan opera, "*The Mikado*" in The Center. Miss

Anne Cole, Director of the Mimics directed the production. The music was under the direction of Mrs. Rugb Bousman, of the Christian Social Center.

Cast of Characters

The Mikado—Ruler of Japan	Santos Belo
Nanki Poo—The Mikado's Son	Abel Silva
Ko Ko—A tailor liberated from jail and made Lord High Executioner	José Quintos
Pooh Bah—Lord High Everything Else	Raul de Arana
Pish Tush—A Noble Lord	Andres Caranto
Katisha—A woman of the Mikado's Court	Mamerta Manahan
Three sisters wards of Ko Ko {	
Yum Yum—Betrothed to Ko Ko	Illuminada Torres
Pitti Sing—A mischievous, fun loving girl	Andrea Balbin
Peep Bo—Shy, adores Yum Yum	Virginia Mondoñedo

Chorus

First tenors:	Numeriano Cuevas; Felix de Leon Flores; Laureano Lucas; Jesus Segovia; Sabas Tangeo; Fernando Torres; Leo Yadao.
Second tenors:	Amado Balingao; Dominador Batenga; Onofre Casupang; Venancio Duarte; Romulo Gines; Federico Paguyo; Felix Remigio.
First basses:	Rocine Base, Primo Castro; Isidoro Dumaua; Guillermo Fran; Miguel Guzman; Rasuman Macalandang; Ladislao Martir; Inocencio Perez; Federico Reyes; Basunie Saropie; Celestino Quilang.
Second basses:	Pedro Lorenzo; Flaviano Oliveros; Constantin Valera.

Only praise can be given the production on every point, the singing, solos, duets, quartets, and chorus; interpretation of characters; costuming, and lighting. Space does not permit special comment. It was a star cast with a galaxy of stars of only little less magnitude for chorus. For clear enunciation both in singing and speaking, words of hearty commendation must be given all.

The comfort of the audience—over 600—in the spacious, well ventilated Center added to the enjoyment of the opera.

Baker Memorial Hall for the morning program, and The Center for *The Mikado* in the evening made this year's Loyalty Day a red letter day for this College.

The seventy-sixth meeting of the Los Baños Biological Club was held on September 29, 1932, at 7:30 p. m. in the Poultry Husbandry lecture room of the College of Agriculture.

The following papers were read and discussed:

1. "Studies on the storage temperature requirements of lansones (*Lansium domesticum* Correa)." By Mr. A. San Pedro
2. "Downy mildew of soy beans" by Miss Victoria B. Mendiola.

The class (24 members) in Agricultural Chemistry 5 (Industrial Chemistry) under Dr. Antonio I. de Leon made a two-day trip to Manila and neighboring towns on September 2 and 3, 1932. Mr. Ricardo Marfori, assistant instructor in chemistry, assisted Dr. de Leon in conducting the students to the different places visited; namely, the Madrigal Cement Plant at Binangonan, Rizal, the pottery works at San Pedro Makati, the Tuason and Sons tile works, the T-V-T printing plant, the Madrigal Cotton Mill, the Malabon Tannery, the Manila Gas Corporation, the Royal Soft Drinks and Ice Plant, the Magnolia Ice Cream and Dairy Products Plant, the Alcohol Distillery of Ynchausti and Company, and the YCO paint factory. The courtesy and coöperation extended the class by the officials and owners of the different establishments visited enabled the students to observe and study many interesting processes involved in the manufacture of the products of the factories and plants.

The class (45 students) in Agronomy 18 (Horticulture) under Dr. Leon Gonzalez and Mr. Ambrosio San Pedro went on an observation trip to Manila on September 8, 1932. The following places were visited:—Singalong Experiment Station, Singalong Flower Gardens owned by Japanese and Filipinos, Paco vegetable gardens owned by Chinese, the International Cold Storage Plant, the Binondo Flower Market, the Aranque and Divisoria Markets. The students had opportunity to see and learn something about how commercial flower and vegetable gardens are run. Also, they gathered information about flower selling, the displaying and keeping of vegetables, and meat, also how meat is kept in Cold Storage in the city markets. The class visited Cementerio del Norte to see the landscape gardening.

Mr. Alfonzo Briones, B. Agr. '29, assistant cane breeder of the Philippine Sugar Association, visited the College during the latter part of July. He brought to the Cane Breeding Station of this College an unknown variety of sugar cane for possible identification.

A letter to Dr. Miguel Manresa from Mr. Swasdi Viradeja '32 tells that Mr. Viradeja is now in the Nonwat Agricultural School in Siam teaching biology and agronomy subjects and doing some research work for the Siamese Research Bureau. Mr. Viradeja writes that there are two other College of Agriculture alumni in that school besides himself doing similar work. The principal of the school is Luang Ingkasrikasi-karn. [(Mr. Iang Chandrastitya B. S. Agr. '21). Mr. Chandrastitya was given his present title which

means, as nearly as it can be expressed in English, "Sir Agriculture", for his work in agricultural teaching.—*Editor*] Mr. Charas Sundarasinha, B. S. Agr. '28 is a teacher in this school. To quote from Viradeja's letter: "Of us three, I am the greenest. I do not know very much about teaching. Students here are weak in English and I am weak in Siamese because I neglected my own language for eight years. The difficulty of the situation both for the teacher and the students is realized when we come to some technical terms because I have to teach in Siamese. However, I have not lost hope as yet. I am trying my best."

Doctor Copeland who made a three weeks trip to Mindanao recently was given a hearty welcome at Pikit, Cotabato by Mr. Fernando Luistro, '15. He is superintendent of the Maridagao Rubber Experiment Station in Cotabato.

Calixto T. Zamuco, '23, of the Trinidad Agricultural School, and Ceferino Villanueva, '27, of Bilar Rural High School, are now assigned to the Central Office of the Bureau of Education in Manila.

Leoncio M. Limpiado, '17, is running his private business, in addition to running the municipality of Naval, Leyte, as its municipal president.

A public nursery was recently started in Lucban, Tayabas, under the direction of Pedro R. Pereyra, '27. He has ten hectares of land to start with. The projects he plans to undertake include: rice, truck gardening, orchard, fishery, and public consultation.

Francisco L. Gestoso, '31, holds the position of Technical Assistant in Agriculture in the Philippine Starch-Sugar Co., Iloilo.

Vicente F. Allarey, '12, is Acting District Agronomist for Agricultural District No. 14, which comprises the provinces of Tayabas and Marinduque.

Report tells us that, Cenon R. Paulican, '17 is Deputy Governor of Bukidnon; Severino R. Santos, '22 is Principal of Ilagan Rural High School in Ilagan, Isabela; Eugenio Celis, '23, is now located in Davao; Gabriel B. Gonzalez, '26, is engaged in hog farming in Paombong, Bulacan; Ernesto E. Elazequi, '29, is farming in Santa Fé, Bukidnon; Ananias T. Crisostomo, '31, is managing a poultry farm in Malolos, Bulacan; David C. Cabrera, '32, is teaching in Batat Rural High School in Ilocos Norte.

ENDEMISM AND THE PROBABLE PRIMARY CAUSES OF ORGANIC EVOLUTION ¹

RICHARD WOLTERECK

Of the University of Leipzig and the Biological Station, Seeon, Bavaria

Endemism means the occurrence of animal and plant forms which are peculiar to different isolated places. The most isolated places of the world are islands, lakes and caves. The study of endemic families, genera, species, and races in areas like these gives us some valuable evidence concerning the problems of evolution and differentiation. Data from this source serve to supply missing gaps in palaeontology and cytological genetics.

The old theories of evolution, Darwinism and Lamarckism, are not sufficient to explain the origin of any new organization, of the co-ordination between different organs forming a whole body, of the harmony existing among different organisms in a community or the accordancę between organism and environment, because these theories take into account only, (1) the occurrence of chance variation or of mutation in casual directions and (2) the direct or indirect influence of the external agencies that compose the environment. Indirect influence results in survival only of varieties which are fitted to a certain environment, while direct influence leads to transformation of the individuals by external forces, and further differentiation of the organs by use and disuse. These factors are secondary; they are not the primary, essential, creative ones.

Are we learning more about the causes of evolution from the facts of endemic differentiation? Or from the facts which are elucidated by the cytological and experimental genetics? The latter facts show the omnipresence of heritable differences in every bisexual organism, caused by the changing combinations within the genic structures of the germ cells, and a certain frequency of small genic mutations occurring repeatedly here and there in every direction. Up to the present time there is no evidence that these oscillations of the genic equilibrium can produce any new organ. It is even probable that the genes are not responsible for any essential "design of organization," but are only of accessory and polymorphic character.

¹ Abridged from a series of three lectures delivered by the author as visiting lecturer of the University of the Philippines at the College of Agriculture.

If neither these genic oscillations nor the external forces of the environment are sufficient to explain any new organization, because they do not contain the primary and creative factor of differentiation, we may examine our experience in endemism and try to find some evidence concerning the internal causes of evolution. Before discussing this difficult question, we will attempt to give a short survey of the real effect of external agencies in the endemic differentiation.

There is, first, the factor space. If a detached colony of any animal or plant settles far away from the original stock, the differences usually become larger than in colonies near by. Grinnell, for instance, has shown this in an excellent analysis of the birds of Lower California and the neighboring islands. This is mainly a question of isolation, but isolation can also become effective where the distances are as short as between Mount Maquiling and Mount Banahao or between Celebes and Borneo.

There is, secondly, the factor time, the length of time available for differentiation. Before coming to the Philippine Islands, I believed, as everybody does, that there is this general law: isolation during a relatively short time—speaking geographically—produces only slight heritable differences in species and races, while differentiation of more thoroughly different species and of groups of species, called “genera,” requires the length of some geological periods. We find, indeed, that the young post-glacial lakes of Northern Europe and America contain slightly differentiated animals as (coregonid fishes and Cladocera), while old lakes, such as those of Central Celebes, contain very peculiar genera of fish and snails. But there is, on the other hand, Lake Taal, apparently a rather young body of water, young at least as an inhabitable niche of life, yet it contains unique fishes, sponges and other forms; and Lake Lanao, isolated from the Bornean fresh water during or after the Pleistocene, and yet containing quite a group of cyprinid genera, all unique but apparently of the same ancestral stock as one Bornean fish (*Barbodes binotatus*, after Herre).

It seems, therefore, that, quite apart from the general influence of length of period of isolation, certain organisms possess the peculiar ability of differentiating faster than others. Likewise, some regions of the earth, as the Philippine Islands or perhaps the whole “unstable area” of Wallacea, are endowed with the unique attribute of accelerating differentiation in their living forms. The last premise concerns a third external factor, the influence of environment. There may be, as Müller suggests, a special influence of natural radiation, possibly stronger in volcanic regions than in more stable

countries, as Northern Europe. Generally, the differentiating influence of environmental factors is obviously very large, although secondary.

A fourth factor is the Darwinian factor, that is, competition in the struggle for life, in which the weak and incapable individuals and varieties are exterminated. The selection of the fittest is, of course, important, but only as a secondary factor.

Which, then, are the primary or creative factors of evolution?

Personally, I consider as the most important result of all our investigations and experiments concerning endemic differentiation our realization of the primacy of internal factors, of definite capacities (potentialities) and trends, immanent in the organism, present as immaterial realities, before they become visible properties of the differentiated form.

We cannot avoid the conception that there is in some organisms, and that there was in the past in all organisms, an internal inborn impetus of evolution, because:

First. Some organisms in some localities and at some time simply show the inherent capacity and trend to change, even to "explode" into a number of different species or races. If we consider the fifty, about, endemic *Haplochromis* fishes living pell-mell in Lake Victoria, which, with one exception, are all unique, or the three hundred gammarids in the bottom mud of Lake Baikal, or the twelve to twenty species of cyprinid fishes in Lake Lanao, we cannot deny some internal causes of such differentiations or explosions, because there are not fifty or three hundred or twenty different localities within these lakes. And if we consider, for instance, the hundreds of very different *Radiolaria* or *Tintinnidae* or *Coccolithophoridae* living pelagically under identical conditions in the same region and the same depths of the Pacific Ocean, we face again the same necessity of admitting immanent capacity and trend to change. (In the case of the *Radiolaria* the event of differentiation has to be dated to very remote times, but this makes no fundamental difference.)

Second and more important. The internal capacity and necessity to change in very many cases shows distinct directions of transformation. Besides some splendid palaeontological series, there are many morphological and geographical series in living forms; for instance, land shells in Sicily, in Celebes, in Hawaii, and, I suppose, also in the Philippines, morphologic chains of Crustacea, of fishes, and so forth. The main thing is that in many cases these series are independent of the ecological character of the environment. Further, in many other cases, in extinct, as well as in living organisms, we ob-

serve monstrous and sometimes evidently noxious exaggerations of a certain character, like the weight and size of antlers, the size and bulk of the whole body (huge tertiary saurians, for instance), the length of appendages (in trilobites, and in pelagic Crustacea of Lake Caspi), complications of the shell (in many extinct Foraminifera and ammonids), weight of the shell of extinct molluscs, and the like.

These exaggerated features are neither useful nor caused by the environment. They prove an internal trend to go on and on in a certain morphological direction.

Third. More difficult to understand than the trend to change, and to change in certain directions, is another fact, also to be learned from endemic differentiation. Some organisms obviously possess the capacity to change in accordance with certain ecological changes, maybe by a kind of "reaction," first, by a physiological difference, and later, by morphological alteration, that is, visible transformation of one or more organs. The ecological changes may concern either the physical environment, or other organisms, with which they constitute a community or biocoenosis. To provide this strange "accordance from inside" would require the analysis of many complicated facts, to be found, for instance, in the balanced associations of some lakes. Here, I may only mention one other case of accordant differentiation which can be explained neither by alteration from outside nor by selection of haphazard useful variation: this is the gall-plant, giving room and board by complicated transformation of its structure to the larvae of a lot of gall-insects, which surely are not useful, often the contrary, to the hospitable plant.

There is another group of facts concerning and proving the primacy of internal causes of evolution to be found in the endemic differentiation in islands and lakes. If we consider more closely the history of some local differentiates and the behavior of some separated stocks of the same species, we find that there are times and states of plasticity and other times and states of non-plasticity in the same kind of organisms, living under identical or very similar conditions.

The first case is that of the dipterocarp trees of Philippine virgin forests. Merrill says that this family is a rather young one, in contrast, for instance, with the Myrtaceae. They do not occur before the Tertiary, for they came to the Philippines probably during the Miocene. Here they differentiated into many peculiar, endemic forms, about 76 per cent of the dipterocarp trees in these islands being endemic species. Now, we have palaeontological evidence that this differentiation was already completed in the following period,

the Pliocene, because in the famous Sagada deposits of that geological age Merrill found exactly the species living today in the same island. That means that no further change did occur during the long Pleistocene period in spite of all the ups and downs of mountains, and the change of climate in this long period as in the period before. So there was a considerable plasticity of these trees in a remote past, but later there was and there is no more plasticity.

Plasticity or instability, that is, capacity and trend to change, can be confined to a certain population or geographical stock, and absent in another population living under exactly the same conditions in another country, exposed it may be, to these conditions originally at a time a little different. *Daphnia pulex*, the common water flea, is living in Europe and North America, in countless pools and post-glacial lakes under absolutely the same average conditions. This species has split up into hundreds of very remarkable local races in North America, while in Europe there are none of these differentiations forming the large *Parapulex* group. In America, the same species, possibly exposed to the post-glacial conditions at a little different time, proved to be the most plastic of all the polymorphic Cladocera of that continent. The same animals, the same external conditions, but apparently not the same internally; so this "inside," the immanent plasticity, seems to be the deciding factor of differentiation. In both cases, the dipterocarp trees and the common water fleas, prove another important thing: that neither the omnipresent little variations of the germ structure, caused by the always changing combinations of genes, nor the usual "small mutations" of single genes can be considered as the sources of specific differentiation, these small mutations occurring, according to Baur and others, in every plant and animal at all times.

If the differentiation of dipterocarp trees happened in this way, why did these alterations stop before or during the Pliocene, in spite of the omnipresence of such nuclear variations? Or if they are indeed the causative factors, why did these variations of the germ structures stop? And if *Daphnia pulex* in America became differentiated in hundreds of specificities through these agencies, why not in Europe, where the same animals with the same set of chromosomes and genes are living exposed to the same external conditions?

It is obvious that there must be something behind all the alterations, something very "interior," changing periodically and sometimes different in different stocks or populations of the same organism.

Besides the interior periodicity of single species sometimes forced from inside to change, and sometimes not, there are the well-known great periods or waves of evolution, three main waves from the Palaeozoic to Mesozoic and Coenozoic times. In every period new types begin to differentiate and become abundant. In a later period the potentialities seem to become exhausted; the germ becomes stable, unchangeable. Some of these great types die out later; apparently the great types as the species begin in a state of vitality and with a wealth of potentialities; later, we observe a loss of these capacities; no more differentiation happens, as in the dipterocarp trees, since the Pliocene time.

This remarkable periodicity of a plastic and a non-plastic stage as an immanent factor is not confined to the great organic types, the classes and orders of animals and plants, and the small types, the single genera or species. Every individual of every kind of organism, man included, shows the same periodicity, the same characteristic curve of development, beginning with the time of youth, rich in potentialities, further continuing as a period of maturity, the potentialities to change more and more, becoming lost, and finally showing the decline, the old age without potentialities, then the end. The same curve, not formed from outside, but immanent in all organisms, in individuals, in species, in the great types.

The amount of plasticity apparently is different in different types, genera, species and races; there are for instance monomorphic genera and polymorphic ones. But the periodical alterations of the plasticity are general, owing to a general law of life.

Sometimes species inclined to produce endemic differentiation, show an unusual plasticity as individuals also, reacting to different external agencies by different shapes, and different looking in different generations. A good example is *Daphnia cucullata* with a long series of morphologic reactions, forming together the so-called "norm of reactions," characteristic and heritable in every race. These daphnids and other Cladocera are also apt to demonstrate the differentiation in accordance to a specific environment, for instance, those living near the surface and near the bottom, migrating vertically through the whole mass of water, or living confined to one narrow layer and there migrating more horizontally. Conspicuous differences of the shape, corresponding to the different direction of moving, occur in these ecologically different races.

As larger animals are better known than smaller, I take as a last example of differentiation a family of birds, the Hawaiian Drepanidae. These occur in very different forms all over these islands,

about forty unique species, forming one unique family. We can try to reconstruct the history of this transformation. The Hawaiian Archipelago came into existence as volcanic islands. In time there was vegetation enough—the seeds arriving by sea-currents, by rafts, and by wind—to give shelter and food to birds, migrating from the north to the south as the golden plover does every year, or driven over the ocean by strong western winds. Some of these birds, finches, warblers, crows and a few birds of prey established themselves, each differentiating later into one or two endemic forms, or not differentiating at all. It seems that the immigration took place at a time when most of the bird families were already specialized and had lost their potentialities to change into other types or shapes.

Then flocks of a little bird belonging to the American creeper family Coerebidae arrived and presumably became the ancestors of the Hawaiian Drepanidae. These birds obviously had not yet lost the capacities of early birds to transform the shape of their bills into different forms: short and thick like the beak of a grosbeak, curved and strong like a parrot's beak, long and curved like the slender bill of a honey-sucker or a humming bird. The new-comers, possessing an average bill, like that of any insect-eating bird, apparently did not find enough insects, but there were trees with an abundance of fruits, hard seeds and sweet flowers. The differentiation began, at first ecologically, than physiologically, some birds eating fruits, some seeds, some the nectar of flowers. At last there resulted a morphological differentiation of three main types of bills, corresponding to the three main kinds of feeding: the fruit-eating Drepanidae began to look like small parrots (*Pseudonestor*), the seed-eating ones like grosbeaks (*Chloridops*), the nectar-eating and most beautiful Drepanidae (*Vestiaria* and others) look exactly like honey-suckers with a long curved and slender bill. I saw those red birds, red like the flowers of the *ohia lihue* tree (*Retrosideros*) high in the mountains of Kauai and Oahu, flying from flower to flower.

This transformation of the bill could not happen by direct influence of the environment, a flower or a fruit not having an acting power to transform anything. Nor can any effect of use be responsible; a bill cannot become longer and longer by use. No better is the explanation by accidental mutations of the bill in a hundred directions, and selection of the three necessary types. Casual genic mutations of an organ like a bill cannot be conspicuous enough in a required direction to give an advantage over the average insect-eater bill of the original creeper.

Formation and transformation of a living being does not happen by accident nor from outside, not by "impression" of material genes or by physical agencies into a substance, transformable in any direction.

Plasticity of an organism is inside, and so is the direction of changing an immanent law and an immanent force to express the invisible law into a visible form. Law and direction and form are, in the case of these birds as in the case of pelagic Cladocera, pleomorphic; they concern a limited number of possible shapes. One of these possible shapes in every case becomes actual reality; that seems to depend on a kind of physiological experience.

The explanation of form by material impression from outside is easy to understand, but wrong. We have to try, I believe, the more difficult explanation by expression of an immanent law and of an interior experience.

THE HEREFORDS IMPORTED BY THE PHILIPPINE GOVERNMENT IN 1920^{1, 2}

VALENTE VILLEGAS
Of the Department of Animal Husbandry

WITH THREE TEXT FIGURES

At the request of former Director F. W. Carpenter of the Bureau of Non-Christian Tribes, with the advice of Dr. B. M. Gonzalez, Professor of Animal Husbandry of the College of Agriculture, University of the Philippines, the following cablegram was dispatched to the Secretary of War, Washington, D. C., U. S. A. on August 2, 1919:

If expense involved be not too great, Mindanao-Sulu provinces require about 100 Hereford bulls, about 20 Hereford heifers from two years to not exceeding five years, selected, medium size, beef type including if possible, several animals of polled strain; all for breeding on (Z)ebu-Philippine cross cows. Animals desired should come from southern ranges tick belt, immune Texas fever, hardy, not accustomed feed except range pasture. Alonzo S. Shealy, Philippine Bureau of Agriculture, now in Augusta, Ga., well informed type cows here and Mindanao pasture conditions, probably would cooperate on your request. Can you arrange purchase and ship under conditions assuring proper care; quick dispatch via United States Army Transport 'Dix' and what will be approximate cost per animal ship-side delivery Manila. Appropriate types rather than expensive pedigreed animals desired, . . .

Thus were brought into the Islands the largest of the consignments of pure-bred cattle developed in a temperate country. Dr. Alonzo S. Shealy of the Bureau of Agriculture took charge of selecting the animals which were shipped from Fort Worth, Texas, U. S. A. The shipment consisted of 100 bulls and 20 cows. Four of the bulls and three of the cows were polled. The animals were loaded on the *U. S. A. Transport Dix* which arrived at Manila on September 8, 1920. During transit five calves were born. The price paid per head for the bulls was from ₱360 to ₱400, for the cows, ₱380. One Polled Hereford bull cost ₱1000. The total purchase price for all the

¹ Experiment Station contribution No. 849. Received for publication September 30, 1932.

² All data incorporated in this paper were supplied by the College of Agriculture, University of the Philippines, Bureaus of Animal Industry and Non-Christian Tribes, Dr. F. C. Gearhart and Messrs. Guy Stratton and Pedro Bulan.

animals, including a premium of four per cent, was ₱48,068.80. In the United States incidental expenses amounting to ₱32,715.53 were incurred.

Origin and age of animals

In table 1, it may be noted that the animals were purchased from fifteen different localities in the state of Texas, principally from Holder, Austin, and Keller. The animals were obtained from 21 breeders, principally from S. P. McInnis of Holder, Burleson and Johns of Austin, and M. W. Hovenkamp of Keller.

The age of the bulls on arrival in the Philippines ranged from one year, 9 months to 5 years, 5 months, the average being 2 years, 10 months. There were only three bulls that were over five years of age; eight were between four and five years old; two were below two years of age; the rest were between two and four years old. The cows averaged four years, one month of age; five were five years or over; eight were between four and five years; and the remainder were below four years, the youngest of them being one year, 11 months.

It may also be noted in the same table that there were four bulls which were also registered in the American Polled Hereford Record. All these animals had been bred by M. W. Hovenkamp. The three cows bearing cross-registration numbers in the American Polled Hereford Record were obtained from H. H. Jefferies, Webb.

Merits of the Herefords justify their importation

Of all the standard breeds of cattle in the temperate regions, the Hereford breed in the opinion of Professor Gonzalez gave promise of being the best choice for introduction into the Philippines to improve the native stock.³ According to Plumb (1920)⁴ the Herefords rank first as grazers owing to their hardiness and ability to rustle in the open pasture; they also excel other breeds in their ability to mature at an early age. The so-called "baby beeves" are produced only by the Herefords. In size, this breed is considered one of the largest among beef cattle. The prepotency of the Herefords is well-known by the uniformity of color and constitutional vigor of the breed that are seen in their progeny. Wherever Herefords have been used for breeding purposes, their offspring are easily recognized by their "white faces" on a colored background. The ability to procreate, or prolificacy, is an additional attribute in favor of this breed.

³ Letter of Prof. B. M. Gonzalez to Governor F. W. Carpenter, July 21, 1919.

⁴ PLUMB, CHARLES S. 1920. Types and breeds of farm animals. Rev. ed., viii + 920 p., 365 fig. Boston: Ginn and Company.

Under Philippine conditions, the bulls, even in their poorest condition and vigor, have shown extraordinary fertility. Dr. J. W. Strong of the American Rubber Company, Isabela de Basilan, Zamboanga, observed that the Hereford bulls are three times as active as the Indian for breeding purposes.

It is also of interest to note, however, that the Herefords have defects that have to be watched for in selecting individuals for breeding purposes. The thighs are generally light and lacking in musculature while the rump often droops down and is narrow. The cows, compared with those of other breeds in temperate countries, do not produce much milk for their young.

Apparent heritable qualities of Herefords under Philippine conditions

General observations on the heritability of Hereford characters under Philippine conditions show general improvement of the offspring in beef qualities, irrespective of the parents, as to whether one is a Native, Indian or their grade. The frame shows great width and the flesh is thick and abundant, especially at the hind quarters. Consequently, there is obtained a corresponding increase in weight. When crossed with an Indian ox the progeny possesses the height of the Indian and the massiveness of the Hereford. Native-Hereford crossbreeds, on the other hand, appear low, but their weight is more than their height indicates. In conformation, the depth and width of chest are markedly shown in the progeny; unfortunately, however, the narrowness between the pin bones seems also to be transmitted. The muscling on the thighs inherited by the offspring could be better improved if the Hereford were not faulty in this respect. Early maturity, a very important attribute of the breed, is commonly seen in the grades. For instance, among range cattle at the College of Agriculture, one Hereford grade heifer, No. 78, calved at one year, eight months and twelve days of age. Counting back 280 days from the date of calving, it is evident that this heifer conceived at about the age of eleven months and two days. Besides precocity in breeding habits, the Hereford appears to produce offspring that mature early so that the body acquires mature proportions at an early age. Contrary to the poor showing of the Hereford cows as milk producers in their native home, the grades produced here have given a good account of themselves as nurse cows. In fact, some of the grades have been used to good advantage at the dairy of the College of Agriculture.

The color pattern of white hair on the face and surrounding parts, on the legs and switch, with the rest of the body red, is more or less uniformly transmitted to the offspring. The colored background may at times be black, and frequently brindling modifies the red coloration of the Hereford parent.

Distribution

Six provinces within the jurisdiction of the Bureau of Non-Christian Tribes; namely, Cotabato, Sulu, Lanao, Mountain Province, Nueva Vizcaya and Zamboanga were recipients of animals from this importation. Zamboanga got the lion's share, 33 bulls and 12



Fig. 1.—The Hereford bull in the center was acquired by the American Rubber Company, Isabela de Basilan, Zamboanga, for breeding purposes. Note the high quality of his offspring. (From photograph by courtesy of the American Rubber Company.)

cows with 5 calves being shipped to this place, the rest of the provinces received from 10 to 14 bulls each. Later on, nine bulls were transferred to Bukidnon, three of which were from Lanao, two from Nueva Vizcaya and four from Zamboanga. Besides these provinces, the Department of Agriculture and Natural Resources obtained three bulls and one cow and the College of Agriculture, University of the Philippines, one bull and four cows. From those allotted to Cotabato, Mr. J. H. Hackett, Manager of the Tamontaka Estate, secured two bulls. A few other private parties had the opportunity to use

bulls from this importation for breeding purposes; namely the American Rubber Company, the Calamba Sugar Estate, the Diklom Ranch, Santa Mesa Dairy Farm, Bukidnon Cattle and Coffee Company, Agusan Coconut Company and Mr. Daniel Sy Cip.

Out of the 12 bulls sent to the province of Sulu, nine died in the early part of 1921, the rest in 1923, 1924 and 1927. By the end of 1924, only two of 14 bulls sent to Cotabato were living, and three of the 10 allotted to the Mountain Province. Of the nine bulls shipped to Bukidnon, one died on the way to its destination, one died in 1924 and four in 1925. The rest of the Herefords died at different times, leaving at present out of the original importation of 1920 one cow at the College of Agriculture and one bull at the Bukidnon Cattle and Coffee Company.

Philippine conditions unfavorable to the Herefords

As a rule, the Philippine environment presented combined factors which were detrimental to the well-being of the Herefords kept on the open range. Not one treatment, or agency, such as feed, temperature, humidity, insect bites and the like could be singled out as being responsible for the rapid dying of practically all the Herefords that were kept in the lowlands. Ordinarily, these animals were found to reduce in flesh gradually, even when additional grain feed was added as supplement to their pasture allowance. The coat became rough and dull and the skin pale and unhealthy. The animals looked dejected and at midday they panted even under shade and were listless. Apparently much relief was afforded if they could wade in the mud; if possible, they congregated in such places in the daytime. During the fly season, the tender parts of the hoof became badly punctured by maggots which had hatched from eggs laid therein. If these maggots were not removed in due time and the sores properly treated, subsequent infection and laming of the feet affected would ultimately cause the death of the animal. Reproduction went on fairly well but a number of young were either weak or born dead. Those that survived became stunted, thus failing to reach normal size at maturity (1926).⁵

On higher elevations, however, the Herefords as range animals, seemed to respond better. It was reported that the bulls sent to Ifugao, Mountain Province, thrived well without extra care. They proved to be good breeders, as there are now about 160 Hereford

⁵ GONZALEZ, B. M. 1926. Experience in the Philippines with the introduction of pure breed animals to improve the common stock. Proceedings of the Third Pan-Pacific Science Congress, Tokyo: 1142-1150.

grades in that region. At the Tamontaka Estate, Mr. Hacket placed two bulls for breeding purposes. For about one year and a half these animals, which arrived in poor condition, failed to improve and one died. The other bull, already very thin, was transferred to Upi in the Tiruray upland of Cotabato where the elevation is about 500 meters above sea level. This animal immediately found himself at home and was soon in prime health. He bred a number of cows and the latest report shows from an original number of ten heifers nearly a hundred head many of which contain seven-eighths of Hereford blood. This bull died in 1929 of old age and heavy breeding work.

*The Herefords at the College of Agriculture, University
of the Philippines*

The Hereford bull purchased by the College of Agriculture arrived here on September 10, 1920. He was then only two years and two months old. This animal was placed on breeding service continuously until January 14, 1928, when he died of septicemia at the age of 9-1/2 years. The four cows acquired by the College came on October 22, 1920. Cow No. 2, the oldest among them, was 5 years, 3 months of age and the youngest cow, No. 4, was only 2 years old. The first of the cows to die was cow No. 5, which died of brain congestion one year and a half after arrival. This cow calved a normal calf and aborted once before she died. Cow No. 2 lived to be 15 years and 4 months old, but during the 10 years of her life here she gave but three calves owing in no small part to her poor health brought about by a chronic ear sore. Cow No. 3 calved six months after she arrived at the College and gave four additional offspring. On September 15, 1930, at the age of 13 years, 5 months, she fell in a ravine, and because of serious injuries she received she was condemned. Her condition then was very poor. The youngest individual of the group, Cow No. 4, is one of the two living Herefords remaining out of the large importation. She is now 13-1/2 years of age, and judging from her appearance her end does not seem near. (See fig. 2.) She began to calve six months after her arrival at the College and to this date has produced six offspring. The intervals between calvings average a little less than two years and two months. Her third calf was dropped 352 days after the second one. She has to her credit two pure breed living heifers, each of which has successfully given birth to full-term calves. The better of the two heifers, No. 17, is now five years of age and has dropped two calves, her first calving occurring when she was two years and six months old. Three bull calves from the College herd were shipped to Jolo in 1924 for

breeding purposes. Altogether, 13 pure breed Herefords have been dropped on the College Farm, of which three heifers, besides Cow No. 4, are now living.

Efforts were made to subject these animals to the same system of management as was given to range cattle with slight modifications. They were turned on pastures that were provided with scattering trees for shelter. When heavy downpours of rain or protracted rainy days occurred the Herefords were brought into the barn to prevent chilling. Grain feeds were supplied to them occasionally, but only when any of them appeared to lose flesh persistently. Ad-



Fig. 2.—Miss Perfection (No. 4). The only cow remaining of the 1920 Hereford importation. Weight, 368 kgm., height, 116 cm. (Photographed at time of writing.

ditional care was also given whenever wounds, eye, ear and foot sores were treated. A regular examination of the body was found necessary to detect ticks; these were removed when they became too numerous.

Besides the 13 pure breed Herefords born at the College, around 80 grades with Hereford blood in varying proportions have also been produced here. Nine of these, of which five are living, have three-fourths Hereford blood. Poor individuals among the grades have been unsexed for slaughtering purposes, but the exceptional ones are being retained.

A number of breeding bulls with Hereford blood have been sold to cattlemen in various parts of the Islands. To Mr. Guy Stratton, former governor of Sulu, were sold in May, 1924, the three pure breed Herefords mentioned elsewhere in this paper. The Mercedes Ranch of Bukidnon secured its first grade Hereford bull from this institution in 1925. Later on, three other grade bulls went to the same ranch. Dr. Toribio Ortega bought one grade bull in 1928 for his herd in Palawan. The last bull to go for improvement work was also a grade. This animal was sold for use in private herd belonging to Dean B. M. Gonzalez, College of Agriculture, and was resold afterwards to Yabo Farm, Naga, Camarines Sur.

Successful breeding operations

Notable among the breeding operations from which Hereford grades have been produced are those of the College of Agriculture, the Bukidnon Cattle and Coffee Company, and the American Rubber Company. The men who were responsible for the use of the Hereford on these ranches followed their operations closely and with much zeal. They were well-informed on the good points and shortcomings of the stock they were using. Their work was, therefore, based on a program of matings best suited to local circumstances.

The good results with the Herefords taken to Ifugao, Mountain Province, certainly deserve attention. It is claimed that the resulting grades are large in size and are faring well in that region. Also, a number of offspring were reported to have been produced by two Hereford bulls which were placed in the herd of Atkins, Kroll & Co., Inc., Cagayan de Sulu. As has been mentioned, the Mercedes Ranch, the Yabo Farm, Dean B. M. Gonzalez, and Dr. T. Ortega have started to use grade Hereford bulls which they acquired from the College of Agriculture. Provincial Treasurer L. Palileo of Cotabato reports using for a sire in a herd of cattle at Taguisa, Cotabato, a 1/2 Hereford-1/2 Indian bull which was bred at Cagayan de Sulu. The Naty Cattle Ranch in Bukidnon obtained two 1/2 Nellore-1/2 Hereford bulls from the Bukidnon Cattle and Coffee Company. For a time, one Hereford bull was kept in the herd of the Lapak Agricultural School, Sulu. As to whether any offspring were produced by this animal the writer does not know.

As early as 1921 or 1922, Dr. J. W. Strong of the American Rubber Company obtained two Hereford bulls out of the 1920 importa-

tion. One of these animals died soon after arrival at Basilan. The other one lived until 1927, and by 1925 had sired 60 calves. Native, Indian and Indian grades were the mother stock.

Mr. Guy Stratton of Jolo has prominently taken part in retaining the Hereford blood among the cattle of the Sulu Archipelago. As early as 1908 he bought from Mr. F. E. Holmes three bulls and two cows of the Hereford breed for breeding purposes. These animals were imported by Mr. Holmes from Port Darwin, Australia. Again, in 1924, he purchased the three Hereford bull calves from the College



Fig. 3.—Grade Hereford cattle on the Gearhart Brothers' Ranch (Bukidnon Cattle and Coffee Company), Bukidnon. Note the large size of animals, and the tendency to ranginess, owing to their Nellore blood. (From photograph by courtesy of the Bukidnon Cattle and Coffee Company.)

of Agriculture. Although most of the original stock died soon after reaching Jolo, the animals that remained were able to breed, leaving a number of beautiful Hereford grades in Sulu.

The Bukidnon Cattle and Coffee Company is using Hereford blood extensively for the improvement of its herd which is basically Indian (Nellore). Basing anticipation on an understanding of the merits of these breeds, each is expected to contribute its good points in developing a good commercial herd. There are now a little over 200 head of Hereford grades on this ranch, of which 20 have three-fourths Hereford blood.

TABLE 1

Showing registry number in the American Hereford Record, breeders and their address, and age of Herefords^a on arrival in the Philippines

REGISTRY NO.	BREEDER AND ADDRESS	AGE ON ARRIVAL IN THE PHILIPPINES
<i>Bulls</i>		
593079	M. M. Cox, Holder, Texas	4 years, 7 months
611722	Rhorne Cattle Co., Kopperl, Texas	5 years, 3 months
611731	J. O. Rhorne, Kopperl, Texas	5 years, 4 months
611732	Rhorne Cattle Co., Kopperl, Texas	5 years, 5 months
623825	B. H. Cogdell, Grandbury, Texas	4 years, 10 months
645024	S. R. Windham, Byrds, Texas	3 years, 6 months
651246	W. K. Boatwright, Baird, Texas	3 years, 3 months
651247	W. K. Boatwright, Baird, Texas	3 years, 2 months
659720	S. R. Windham, Byrds, Texas	3 years, 7 months
678530	W. K. Boatwright, Baird, Texas	2 years, 11 months
685065	J. O. Rhorne, Cleburne, Texas	4 years, 4 months
685079	J. O. Rhorne, Cleburne, Texas	4 years, 6 months
685085	J. O. Rhorne, Cleburne, Texas	4 years, 7 months
685099	Rhorne Cattle Co., Kopperl, Texas	4 years, 3 months
685107	Rhorne Cattle Co., Kopperl, Texas	4 years, 6 months
685121	Rhorne Cattle Co., Kopperl, Texas	4 years, 7 months
687222	Joe Eddings, Eden, Texas	3 years
687224	Joe Eddings, Eden, Texas	2 years, 11 months
692303	S. P. McInnis, Holder, Texas	3 years, 6 months
692304	S. P. McInnis, Holder, Texas	3 years, 4 months
693402	Burleson & Johns, Austin, Texas	3 years, 7 months
693403	Burleson & Johns, Austin, Texas	3 years, 5 months
693406	Burleson & Johns, Austin, Texas	3 years, 5 months
693408	Burleson & Johns, Austin, Texas	3 years, 5 months
693414	Burleson & Johns, Austin, Texas	3 years, 6 months
697405	Burleson & Johns, Austin, Texas	3 years, 7 months
697683	S. P. McInnis, Holder, Texas	2 years, 10 months
705910	R. C. Rhorne, Jr., Saginaw, Texas	2 years, 11 months
706155	Est. C. T. Whitley, Keller, Texas	2 years, 6 months
706158	Est. C. T. Whitley, Keller, Texas	2 years, 5 months
710778	W. K. Boatwright, Baird, Texas	2 years, 7 months
710780	W. K. Boatwright, Baird, Texas	2 years, 6 months
710783	W. K. Boatwright, Baird, Texas	2 years, 7 months
718885	Burleson & Johns, Austin, Texas	2 years, 8 months
718886	Burleson & Johns, Austin, Texas	2 years, 8 months
718887	Burleson & Johns, Austin, Texas	2 years, 8 months
718888	Burleson & Johns, Austin, Texas	2 years, 8 months

^a Registry Nos. in parenthesis refer to those in American Polled Hereford Record. The certificate of one of the animals was lost.

TABLE 1—Continued

REGISTRY NO.	BREEDER AND ADDRESS	AGE ON ARRIVAL IN THE PHILIPPINES
718889	Burleson & Johns, Austin, Texas	2 years, 8 months
718897	Burleson & Johns, Austin, Texas	2 years, 8 months
724314	S. P. McInnis, Holder, Texas	2 years, 7 months
724318	S. P. McInnis, Holder, Texas	2 years, 7 months
724319	S. P. McInnis, Holder, Texas	2 years, 6 months
724420	Burleson & Johns, Austin, Texas	2 years, 7 months
724421	Burleson & Johns, Austin, Texas	2 years, 7 months
724425	Burleson & Johns, Austin, Texas	2 years, 7 months
724430	Burleson & Johns, Austin, Texas	2 years, 7 months
724761	B. C. Rhome, Jr., Saginaw, Texas	2 years, 7 months
726965	D. A. Wright & Son, Holder, Texas	2 years, 5 months
727827	Cox and McInnis, Byrds, Texas	2 years, 6 months
727828	S. R. Windham, Byrds, Texas	2 years, 7 months
727829	S. R. Windham, Byrds, Texas	2 years, 5 months
733349	S. P. McInnis, Holder, Texas	2 years, 6 months
733355	S. P. McInnis, Holder, Texas	2 years, 6 months
733358	S. P. McInnis, Holder, Texas	2 years, 5 months
733366	S. P. McInnis, Holder, Texas	2 years, 6 months
733373	S. P. McInnis, Holder, Texas	2 years, 5 months
733376	S. P. McInnis, Holder, Texas	2 years, 5 months
737716	Burleson & Johns, Austin, Texas	2 years, 6 months
737723	Burleson & Johns, Austin, Texas	2 years, 5 months
738137	M. W. Hovenkamp, Keller, Texas	2 years, 6 months
(20117)		
738140	M. W. Hovenkamp, Keller, Texas	2 years, 6 months
743742	Burleson & Johns, Austin, Texas	2 years, 6 months
750830	Joe Eddings, Eden, Texas	2 years, 2 months
752796	Joe Eddings, Eden, Texas	2 years, 5 months
752797	Joe Eddings, Eden, Texas	2 years, 5 months
755505	W. M. Baugh & Son, Brownwood, Texas	2 years, 4 months
755509	W. M. Baugh & Son, Brownwood, Texas	2 years, 5 months
755515	W. M. Baugh & Son, Brownwood, Texas	2 years, 4 months
755516	W. M. Baugh & Son, Brownwood, Texas	2 years, 5 months
757836	Cox & McInnis, Byrds, Texas	2 years, 6 months
757837	Cox & McInnis, Byrds, Texas	2 years, 6 months
758251	S. P. McInnis, Holder, Texas	2 years, 5 months
759121	Mrs. B. S. Rhome Jr., Saginaw, Texas	2 years, 5 months
759279	B. S. Rhome, Jr., Saginaw, Texas	2 years, 1 month
761952	M. W. Hovenkamp, Keller, Texas	2 years, 4 months
761955	M. W. Hovenkamp, Keller, Texas	2 years, 5 months
765899	M. W. Hovenkamp, Keller, Texas	2 years, 5 months
765901	M. W. Hovenkamp, Keller, Texas	2 years, 4 months
(20118)		
765905	M. W. Hovenkamp, Keller, Texas	2 years, 4 months

TABLE 1—Continued

REGISTRY NO.	BREEDER AND ADDRESS	AGE ON ARRIVAL IN THE PHILIPPINES
765907	M. W. Hovenkamp, Keller, Texas	2 years, 4 months
765909	M. W. Hovenkamp, Keller, Texas	2 years, 2 months
769476	A. McInnis, Holder, Texas	2 years, 8 months
769478	A. McInnis, Holder, Texas	2 years, 4 months
769479	A. McInnis, Holder, Texas	2 years, 5 months
769481	A. McInnis, Holder, Texas	2 years, 9 months
769483	A. McInnis, Holder, Texas	2 years, 4 months
770464	S. P. McInnis, Holder, Texas	2 years, 2 months
770465	S. P. McInnis, Holder, Texas	2 years, 2 months
771200	S. P. McInnis, Holder, Texas	2 years, 3 months
771201	S. P. McInnis, Holder, Texas	2 years, 2 months
771203	S. P. McInnis, Holder, Texas	2 years, 2 months
783718	Cox & McInnis, Byrds, Texas	2 years.
783719	Cox & McInnis, Byrds, Texas	2 years.
784378	B. C. Rhome, Jr., Saginaw, Texas	3 years, 5 months
787583	B. C. Rhome, Jr., Saginaw, Texas	3 years, 6 months
795893	M. W. Hovenkamp, Keller, Texas	1 year 11 months
(20120)		
795894	M. W. Hovenkamp, Keller, Texas	1 year, 9 months
	<i>Cows</i>	
529573	Est. C. T. Whitley, Keller, Texas	5 years, 3 months
529574	Est. C. T. Whitley, Keller, Texas	5 years, 2 months
536670	M. W. Hovenkamp, Keller, Texas	5 years, 10 months
536678	M. W. Hovenkamp, Keller, Texas	5 years, 7 months
573462	T. B. White, Arlington Texas	5 years
592776	H. H. Jefferies, Webb, Texas	4 years, 5 months
592786	H. H. Jefferies, Webb, Texas	4 years, 9 months
592801	H. H. Jefferies, Webb, Texas	4 years, 4 months
592776	H. H. Jefferies, Webb, Texas	4 years, 5 months
(19941)		
592786	H. H. Jefferies, Webb, Texas	4 years, 8 months
(19943)		
592801	H. H. Jefferies, Webb, Texas	4 years, 4 months
(19945)		
596373	M. W. Hovenkamp, Keller, Texas	4 years, 6 months
596379	M. W. Hovenkamp, Keller, Texas	4 years, 4 months
651278	W. A. McClure & Brothers, Christian, Texas	3 years, 5 months
651279	W. A. McClure & Brothers, Christian, Texas	3 years, 5 months
656218	M. W. Hovenkamp, Keller, Texas	3 years, 5 months
667848	Est. C. T. Whitley, Keller, Texas	3 years, 5 months
667852	L. & R. Whitley, Keller, Texas	3 years, 8 months
696467	M. W. Hovenkamp, Keller, Texas	3 years, 6 months
764202	Burgess Smith, Haslet, Texas	2 years
764203	Burgess Smith, Haslet, Texas	2 years
795896	M. W. Hovenkamp, Keller, Texas	1 year, 11 months

INFLUENCE OF SMUDGING ON THE RESPIRATION AND CATALASE ACTIVITY OF THE MANGO, *MANGIFERA* *INDICA* LINN.¹

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WITH ONE TEXT FIGURE

In an earlier paper (1923) the writer showed that a well-regulated, continuous process of smudging will cause mature mango trees to flower any time of the year. Results of the experiment seemed to show that the increased heat produced by the smudges was the primary factor responsible for the earlier appearance of the flower buds. In the experiment, however, there were other factors that were not eliminated and these may have been equally as important as heat. For instance, the abundance of carbon dioxide coming from the smudges may have resulted in an increase in photosynthate which in turn may have had an influence on the opening of the flower buds. Also, other gases evolved in the process of combustion may have had some effect on the appearance of the flowers. To check these points and to determine the effects of smudging on the respiration of the leaves and twigs and on the catalase activity of the different tissues of the mango, the experiment discussed in this paper was conducted.

Part of the work was done from January to March, 1923 and part in February, 1932. All experiments were performed in the College of Agriculture at Los Baños.

MATERIALS AND METHODS

Old trees of mango of the Pico variety were used in the experiment. Trees were selected according to similarity in size, stage of maturity of the leaves, exposure to sunlight and to other external characteristics.

Dried grass and rubbish of various kinds were used as smudging fuel. Green grass and rice hulls were placed on top of the smudge to check rapid combustion of the dried material and to produce a column of smoke which served as the heat conductor. The fire was kept burning night and day, care being taken not to burn the leaves

¹ Experiment Station contribution No. 850. Read before the First Philippine Science Convention held under the auspices of the Philippine Scientific Society, March 15-17, 1932, Manila, P. I. Received for publication September 10, 1932.

of the tree. Temperature measurements at different heights in the tree were made three times a day—in the morning, at noon and in the afternoon.

To prevent the branches from coming in contact with gases evolved by the combustion of the smudging material, they were covered with test tubes. The leaves were removed, leaving short portions of the petioles. The mouth of the test tube was plugged with cotton and covered with vaseline.

In some cases the branches were covered with paraffined paper bags. The bag was tied snugly, but not tight enough to produce constriction, at the base of the branch about 30 centimeters from the terminal bud.

Other branches, used as control, were tagged but given no other treatment.

The titrametric method of determining carbon dioxid was used in measuring the respiration of the leaves and twigs. The same apparatus which was used in determining the respiration of the chico (Gonzalez, 1931) was employed in this experiment, taking special precaution to guard against air leaks. All carbon dioxid measurements were taken after passing the carbon dioxid-free air into the respiration chamber for three hours. The temperature of the bath was kept constant at 27°C. The total duration of the individual experiment did not exceed 12 hours.

The twigs used in the carbon dioxid determinations were cut about 30 centimeters long and brought to the laboratory. Here, they were recut under water to lengths of about 20 centimeters.

A few basal leaves were cut off and the free end of the branch inserted under water in a 50 cc. Erlenmeyer flask filled to within about 2 cm. of the mouth. The opening was plugged with cotton and covered well with warm paraffin. After the experiment, the weight of the branch, the number of leaves, length and circumference of the twig were taken. The weights of branches used varied from 49.0 to 63.3 grams; number of leaves from 11 to 14; length of stem, 18.5 to 20.0 cm.; and circumference of stem from 2.5 to 3 cm.

Catalase was determined by the method used by Heinicke (1923, 1924). Samples of leaves were gathered with a cork borer, five millimeters in diameter. In gathering, care was taken to exclude the veins. A disc was taken from each of about 50 leaves; the discs were mixed well. From the composite, two samples of 300 milligrams each were weighed. To each sample in a porcelain mortar, was added 300 milligrams of calcium carbonate and a small amount of purified quartz sand. A few drops of distilled water were added to cover the

tissue with the carbonate paste after which the discs were macerated for three minutes or until a fine suspension was obtained. Enough distilled water was added to make a total of 10 cc. After stirring the mixture well it was placed in a stoppered Erlenmeyer flask and stored in the laboratory at room temperature. Catalase determinations were made within two hours after the preparation of the sample. Duplicate determinations were taken from each sample.

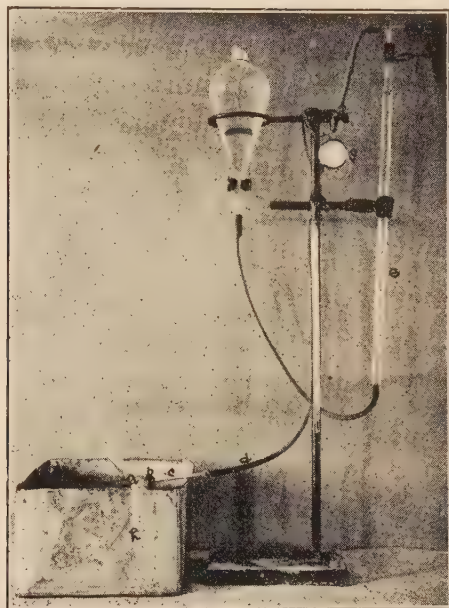


Fig. 1.—Apparatus for catalase determination: (a) reaction tube blown to a Y-form; (b) small one-holed rubber stopper; (c) glass tubing; (d) rubber tubing; (e) graduated burette; (f) pinchcock; (g) watch; (h) water bath.

The main parts of the apparatus (see figure 1) consisted of a two-arm reaction tube *a* fitted with a one-hole rubber stopper *b*; a short piece of glass tubing *c* connected to the rubber tubing *d* and then to the burette *e*. At the head of the burette was a T-tube, one arm of which was connected to a short rubber tubing provided with a pinchcock *f*. Two cc. of the prepared tissue was pipetted into one arm of the reaction tube and into the other was placed 4 cc. of fresh hydrogen peroxide (Mallinckrodt 10 volumes).

After connecting the reaction tube to the stoppered glass lever it was immersed in water bath *h* kept at a constant temperature of 30°C. The pinch-cock *f* was opened until the level of the water in

the burette stood at the zero mark. After 5 minutes under water the two liquids were mixed by turning the glass lever *C* and making them flow from one arm of the tube to the other at the rate of about 30 complete swings per minute. The time in seconds it took to liberate 1 to 3 cc. of gas was recorded.

EXPERIMENTS AND RESULTS

In the smudging experiments, two trees were used each time. One was smudged while the other was used as control. In the second experiment a third tree was selected for pairing with the control tree in the first experiment which was smudged in the second experiment. Other details and results of the experiment are shown in table 1.

TABLE 1
Effect of covering the branches of mango during smudging

DATE 1923	TREE NO.	TREATMENT GIVEN TO THE TREE	HOW BRANCHES WERE COVERED	NUMBER OF BRANCHES USED	NUMBER OF BRANCHES FLOWERED	PERCENTAGE OF BRANCHES THAT FLOWERED	NUMBER OF BRANCHES PRODUCING NEW FLUSH
Jan. 11	1	smudged	bagged	100	63	63.00	6
			test tube	125	97	77.60	7
			not covered	200	174	87.00	13
	2	not smudged	bagged	100	none		none
			test tube	120	"		"
			not covered	135	"		"
Feb. 18	2	smudged	bagged	189	15.4	81.48	8
			test tube	125	101	80.80	5
			not covered	200	182	91.00	7
	3	not smudged	bagged	100	none		none
			test tube	125	"		"
			not covered	200	"		"
March 7	3	smudged	bagged	190	134	70.53	27
			test tube	120	98	81.67	2
			not covered	120	105	87.50	7
	4	not smudged	bagged	100	none		none
			test tube	100	"		"
			not covered	100	"		"
March 28	4	smudged	bagged	200	129	64.50	14
			test tube	100	87	87.00	3
			not covered	100	90	90.00	none
	5	not smudged	bagged	100	none		63
			test tube	118	"		89
			not covered	100	"		52
Av. percentage of branches that flowered		not smudged; none flowered	smudged	bagged 69.88±2.830 test tube 81.77±1.315 not covered 88.88±0.651			

In the respiration experiments, two trees were used, one as control, the other for smudging. Samples were taken from the two trees a few days before smudging. The results were computed on the basis of milligrams carbon dioxid per kilogram of sample per hour. The results of the experiment are shown in table 2.

TABLE 2
Influence of smudging on the respiration of twigs and leaves of mango

DATE 1932	TREE NO.	DURATION OF EXPERI- MENT	MGM. CO ₂ PER KGM. HOUR			
			Sample 1	Daily av.	Sample 2	Daily av.
Feb. 23	1	1.00	236.06	.....	267.09	.....
		1.00	266.42	.....	270.41	.....
		1.00	226.15	242.88	226.52	254.67
Feb. 28	1	1.00	254.27	.....	260.25	.....
		2.00	257.05	.....	254.20	.....
		1.00	244.72	252.01	259.21	257.89
Average of all determinations					251.86±2.176	
Feb. 18	2	1.00	194.50	.....	258.02	.....
		2.00	187.71	.....	236.40	.....
		1.50	196.64	.....	270.09	.....
		1.00	189.45	192.08	252.24	254.19
Feb. 19	2	1.00	284.91	.....	230.31	.....
		2.00	259.39	.....	227.96	.....
		1.00	235.27	.....	236.10	.....
	Smudged Feb. 25	1.50	243.20	255.69	235.70	232.52
Average of all determinations					235.87±9.996	
Feb. 27	2	1.00	491.55	.....	390.45	.....
		1.00	445.89	.....	337.86	.....
		2.00	444.72	.....	354.54	.....
		1.00	427.38	452.38	327.62	352.62
Feb. 28	2	1.00	385.76	.....	367.89	.....
		1.00	392.73	.....	376.47	.....
		1.00	398.27	392.25	384.25	376.20
Average of all determinations					393.46±14.347	

The catalase activity of the leaves, terminal buds, bark and wood of stems not larger than 3 cm. in circumference was determined. Three sets of samples were taken, one on the 16th of February; one on the 18th; and one on the 19th. The tree was smudged on the 25th. Other determinations were taken on the 26th, 27th, 28th and 29th. The results are shown in table 3.

TABLE 3
Influence of smudging on the catalase activity of the mango

TISSUE USED AND SAMPLE NO.	TIME PER CC. OF GAS EVOLVED						
	Before smudging			After smudging			
	2-16-32	2-18-32	2-19-32	2-26-32	2-27-32	2-28-32	2-29-32
	sec.	sec.	sec.	sec.	sec.	sec.	sec.
Leaves							
1a	15	7	10	9	6	12	8
1b	18	7	10	10	7	8	7
2a	19	8	9	8	6	7	6
2b	14	9	10	9	7	6	6
3a	15	10	11	8	6	7	5
3b	15	10	10	10	6	6	6
Average	16	8.5	10	9	6.3	7.7	6.3
Averages of all determinations ..	11.5±1.524			7.3±0.428			
Terminal bud							
4a	52	31	17	22	36	16	37
4b	48	34	20	24	35	16	36
5a	56	30	24	32	31	21	32
5b	42	33	21	30	26	21	33
6a	49	32	20	28	39	28	12
6b	47	33	21	28	35	29	18
Average	49	32.17	20.5	27.33	33.67	21.83	28.0
Averages of all determinations ..	33.89±5.47			27.71±1.625			
Bark							
7a	67	56	54	88	75	56	20
7b	69	58	56	92	80	59	22
8a	71	69	59	84	65	64	21
8b	74	71	58	86	66	66	22
9a	70	56	75	58	75	54	30
9b	72	59	82	56	77	57	32
Average	70.5	61.5	64.0	77.33	73.0	59.33	24.5
Averages of all determinations ..	65.33±1.807			58.54±2.922			
Wood							
10a	174	161	191	141	126	123	54
10b	172	179	194	152	128	126	57
11a	179	198	196	135	131	139	61
11b	175	260	200	145	142	142	65
12a	180	164	210	167	172	111	59
12b	183	172	221	169	176	112	62
Average	177.17	190.0	202.0	151.66	145.83	125.50	59.67
Averages of all determinations ..	189.72±4.63			120.65±14.231			

DISCUSSION OF RESULTS

The marked influence of smudging in forcing the flowering of mango may be seen in table 1. In all cases the smudged trees flowered and the unsmudged trees did not.

Comparing the bagged branches with those covered with test tubes and those not covered the differences in percentages of flowering are all significant. The averages are 88.88 ± 0.651 per cent for not covered; 81.77 ± 1.315 per cent for those covered with test tubes; and 69.88 ± 2.830 per cent for the bagged ones. The differences are 19.00 ± 2.905 per cent between not covered and bagged; and 7.11 ± 1.46 per cent between not covered and covered with test tubes. The efficiency of the different methods of covering, however, is not the important point in this experiment, but rather the fact that the branches flowered even when defoliated and when carbon dioxid and other gases of combustion were excluded. Of course there is the possibility of stimulation of the covered branches transmitted through the other uncovered branches. But it is commonly observed that in mango the response of the different branches to a given stimulus is rather localized. For example, it is common to see a mango tree with about one-third of its branches flowering, one-third producing new flushes and the other third of the tree not showing any apparent external change. Hence, it seems safe to conclude that heat is by far the most important of the factors here considered responsible for the early flowering.

The difference in the rate of respiration between trees 1 and 2 before smudging is not significant. The average of all determinations for tree 1 was 251.86 ± 2.176 mgm.; and for that of tree 2 before smudging, 235.87 ± 9.99 mgm., with a difference of 27.99 ± 10.23 mgm. After smudging for two days the rate of carbon dioxid output increased considerably. Compared with tree 1 the difference is 141.60 ± 14.51 mgm. and with the activity before smudging, 159.59 ± 17.62 mgm.

The catalase activity of all tissues used was increased as a result of smudging. Computed statistically, however, only that of the wood is significant. The average activity before smudging was 189.72 ± 4.64 seconds per cc., and after smudging, 120.65 ± 14.23 seconds or a difference of 69.07 ± 6.99 seconds.

SUMMARY AND CONCLUSIONS

All trees smudged in this experiment flowered; the control trees did not.

Branches covered with test tubes and paraffined paper bags flowered when the tree was smudged. This result suggests that heat is the primary factor in the early flowering, not CO₂ or other products of combustion. More of the exposed branches flowered than of those covered with test tubes or paper bags. There is a possibility that the stimulus of smudging exerted on the exposed branches may have been transmitted to the covered ones, but it is commonly observed that with the mango, stimulation to vegetative growth or flowering may be localized.

Following smudging, there was a significant increase in rate of respiration of the leaves and twigs of mango trees.

There were slight but consistent increases in the catalase activity of the leaves, terminal buds and bark as influenced by smudging. The increase in activity in the wood is very significant.

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FOUR NEW DISEASES OF PHILIPPINE ECONOMIC PLANTS CAUSED BY SPECIES OF THE FAMILY PYTHIACEAE¹

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WITH FOUR TEXT FIGURES

The writer's attention was attracted by the occurrence on important economic plants at the College of Agriculture in Los Baños of new diseases caused by a species of fungi belonging to the family Pythiaceae. These fungi cause varying symptoms as root rot, blight, wilt and damping-off. In the present paper is given a brief description of each of the four new diseases; studies on the causal organisms are in progress.

PINEAPPLE WILT

Pineapple plants [*Ananas comosus* (Schultes) Merr.] variety Sweet Cayenne affected by a wilt disease were noted and collected from the pineapple plantings in the Coconut Grove barrio and in the barrio of San Antonio, Los Baños, Laguna. The disease seriously affects the stand of the pineapple in the field and causes a damage estimated at not less than 20 per cent of the plants. The same disease was present among the 150 suckers submitted by plant pathology students. Since the disease has not hitherto been reported in the Philippines it attracted the attention of the writer. Sideris (1929)² reports a species of *Phytophthora* causing stem and root rot diseases of pineapple in Hawaii.

Description of the disease

The disease may be readily recognized on the foliar or aërial portion of the plant. The normal green appearance gradually disappears and the plant becomes pale yellow. The yellowing is followed sooner or later by general wilting. In serious cases, when the leaves are just starting to lose the normal green color, the entire plant suddenly collapses and the whole structure falls over on the ground. In such cases the seat of infection can be located at the tender leaf bases.

¹ Experiment Station contribution No. 851. Received for publication, March 25, 1932.

² SIDERIS, C. P. 1929. Stem rot of pineapple plants. *Phytopathology* 19: 1146. (Abstract)

The point of infection is markedly discolored with irregularly zonated water-soaked areas. The entire cabbage of the pineapple may be involved. In mild cases of infection the wilting is persistent. If infection is not intensified by favorable environmental factors, the diseased plants only remain wilted for some time, but they never recover from the infection. Wilted plants may be readily pulled up because the root system is very poorly developed owing to effect of the disease (fig. 1). Infected plants invariably die prematurely.

Causal organism

Microscopic examination of free hand sections of the discolored tissue from tender leaf bases and pieces of rotted roots carefully



Fig. 1.—Pineapple wilt disease caused by species of *Phytophthora*.
(All photographs by Photographic Division, Department of Soils.)

teased apart in a drop of water on a slide, showed the presence of an abundance of non-septate, hyaline mycelium. When pieces of infected tender leaf tissue were placed on steamed corn meal in petri dishes the fungus developed in pure cultures. The fungus produces numerous conidia which are lemon shaped and typical of those of the species of *Phytophthora*.

BLIGHT AND ROOT ROT ABACÁ SEEDLINGS

This disease was observed among the experimental potted abacá seedlings (*Musa textilis* Née) grown from seeds in the Department of Plant Pathology. The disease was very serious. Within a com-

paratively short time all the seedlings sown in moderate thickness in 24-cm. pots were almost wiped out.

Description of the disease

The most characteristic feature of the disease is the blighted appearance of the leaves of the seedlings. Water-soaked blotches are produced on the leaves (fig. 2). The disease may attack either the



Fig. 2.—Blight and root rot of abacá seedlings caused by a species of *Pythium*. Natural infection.

roots or the leaves or both. If the roots only are infected the resulting effect is damping-off. Infection of the tender pseudo-stems of the seedlings causes them to fall over. If the infection is confined to the leaves, the disease causes blighting.

Causal organism

After a careful examination for the cause, following the usual laboratory method, it was found that a species of *Pythium* was consistently associated with diseased seedlings. Besides the mycelium of the fungus, there are present profusely, oöspores. The oöspores are smooth, globose or sub-globose. The fungus was easily isolated to pure culture on steamed corn meal in petri dishes.



Fig. 3.—Wilt disease of avocado seedlings caused by a species of *Pythium*.

AVOCADO-SEEDLING WILT

Avocado (*Persea americana* Mill.) seedling wilt was noted among the experimental seedlings in the Department of Plant Pathology. The disease causes a sudden wilting of the plants similar to that resulting when they are deprived of proper water supply.

Description of the disease

Diseased plants display drooping leaves which roll up gradually and lose the natural green color. The wilting persists unabated until the plants die. In the more advanced stages of the disease the portion of the main stem immediately above the ground may be shrunk and dark brown (fig. 3). The plant can be pulled up with ease as the root system is severely affected. The rootlets are rotted, soft and flaccid.

Causal organism

Pieces of diseased rootlets were carefully teased apart in a drop of water on a slide and examined under the microscope. Numerous



Fig. 4.—Damping-off disease of pine seedlings caused by *Pythium debaryanum* Hesse.

hyaline, non-septate mycelium, penetrating both the cortex and the woody portions of the rootlets were found. Isolations were made upon steamed corn meal and a white cottony or downy growth, characteristic of phycomycetous fungi, developed. A few days later the culture produced an abundance of globose to sub-globose spores. The globular structures were oöspores of a species of *Pythium*.

DAMPING-OFF OF BENGUET AND CHINESE PINE SEEDLINGS

Diseased specimens of Benguet pine (*Pinus insularis*) and imported Chinese pine (*Pinus massoniana*) seedlings were submitted

to the Department of Plant Pathology by the School of Forestry at Los Baños for determination of the causal fungus.

Description of the disease

Every seedling showed that its main stem, just above the soil, was water-soaked, shrunken, and soft (fig. 4). This condition caused the seedlings to fall over on the soil, resulting in a serious damped-off condition.

Causal organism

Microscopic examination of pieces of the wet rotted stems placed in a drop of water revealed at once the presence of profuse conidia and oöspores intermingled with the hyaline non-septate mycelium of the fungus. The fungus is similar to if not identical with *Pythium debaryanum* Hesse, a most common and destructive soil-borne fungus causing damping-off of seedlings of important agricultural crops. *Pythium debaryanum* attacks pine seedlings in forest nurseries in the United States.

COMPARATIVE MINERAL CONTENTS OF PHILIPPINE BANANAS: CALCIUM, IRON, MAGNESIUM AND PHOSPHORUS ¹

JULIAN R. MARTINEZ

The banana is one of the most common and widely grown fruits in the Philippines. It forms an important part of the Filipino dietaries; it is available in fresh condition at all times of the year and is comparatively cheap. Hence, a knowledge of its mineral content should be of importance.

The work here reported was performed in the Department of Agricultural Chemistry from November, 1930 to January, 1932.

MATERIALS AND METHODS

The following varieties of bananas were analyzed:

- | | |
|---------------|-------------------|
| (1) Buñgulan | (11) Misi Luke |
| (2) Butuan | (12) Morado |
| (3) Dinalaga | (13) Oaňa |
| (4) Galatayan | (14) Pitogo |
| (5) Ginaring | (15) Saba |
| (6) Inarnibal | (16) Sabang Iloco |
| (7) Katali | (17) Tampohin |
| (8) Khai Pet | (18) Ternate |
| (9) Lacatan | (19) Tiparot |
| (10) Latundan | (20) Tundoc |

These varieties of bananas were obtained in the Calamba, Los Baños, and San Pablo markets, and from the College of Agriculture. Some of the varieties were identified by Dr. L. G. Gonzalez, of the Department of Agronomy, and the scientific names were checked by Dr. J. B. Juliano of the Department of Plant Physiology, both of this College.

¹ Part of thesis presented for graduation, 1932, with the degree of Bachelor of Agriculture from the College of Agriculture No. 336; Experiment Station contribution No. 852: Prepared in the Department of Agricultural Chemistry under the direction of Dr. F. O. Santos.

Samplings. Fresh ripe banana fruits were peeled and chopped into small pieces which were at once mixed and five representative samples of 5-10 grams each were taken for moisture and ash determinations. Care was taken to remove the seeds of seeded varieties as these are undigestible.

The remaining bulk of chopped pulp was dried, charred, and then ashed in an electric muffle furnace. From this ash the different ash constituents under study were determined. The weighing vials containing the ash were shaken a number of times before a sample was removed.

Methods of analysis. The methods of analysis employed in all the determinations were those adopted by the Association of Official Agricultural Chemists.²

RESULTS

The results are given in the table.

1. The ash content of Philippine bananas ranges from 0.74 to 1.27 per cent.
2. Pitogo, Butuan, Lacatan, Tiparot, and Saba are comparatively high in calcium oxide.
3. Pitogo, Buñgulan, Saba, Latundan, and Ternate are comparatively high in ferric oxide.
4. Lacatan, Saba, Pitogo, Tiparot, and Ternate are comparatively high in magnesium oxide.
5. Pitogo, Saba, Lacatan, Latundan, and Tiparot are comparatively high in phosphoric acid anhydride.

² ANONYMOUS. 1925. Official and tentative methods of analysis of the association of official agricultural chemists. 2nd ed., xvi + 535 p., 25 fig. Washington, D. C.

TABLE
Showing the calcium oxide, ferric oxide, magnesium oxide, and phosphoric acid anhydride content of Philippine bananas

NAME OF VARIETIES	MOIS- TURE	ASH		CALCIUM OXIDE IN				FERRIC OXIDE IN				MAGNESIUM OXIDE IN				PHOSPHORIC ACID IN			
		per cent	per cent	Ash	Dry mate- rial	Sample ana- lyzed	per cent	per cent	Ash	Dry mate- rial	Sample ana- lyzed	per cent	per cent	Ash	Dry mate- rial	Sample ana- lyzed	per cent	per cent	
1. Buñulan (Tag.) <i>Musa sapientum</i> Linn. var. <i>suaveolens</i> (Blanco) Teodoro	75.57	0.93	2.03	.0774	.0189	1.94	.0737	.0180	7.82	.2976	.0727	.0727	.0727	16.29	.6201	.1515	1		
2. Butuan (Tag.) <i>Musa errans</i> (Blanco) Teodoro var. <i>botoan</i> Teodoro	71.05	0.74	3.32	.0850	.0246	1.11	.0283	.0082	7.89	.2017	.0584	.0584	.0584	21.63	.5530	.1601	2		
3. Dinalaga (Tag.) <i>Musa sapientum</i> Linn. var. <i>dinalaga</i> Quis.	69.10	0.86	0.52	.0146	.0045	0.91	.0252	.0078	6.29	.1751	.0541	.0541	.0541	14.17	.3945	.1219	3		
4. Galatayan (Tag.) <i>Musa sapientum</i> Linn. var. <i>galatayan</i> Quis.	73.73	1.20	1.39	.0636	.0167	0.61	.0278	.0073	3.63	.1660	.0436	.0436	.0436	12.59	.5752	.1511	4		
5. Ginaring (Tag.) <i>Musa sapientum</i> Linn. var.	75.54	1.06	1.34	.0581	.0142	0.69	.0298	.0073	5.42	.2351	.0575	.0575	.0575	12.60	.5462	.1336	5		
6. Inaribal (Tag.) <i>Musa sapientum</i> Linn. var. <i>inaribal</i> Teodoro	76.07	0.85	1.68	.0598	.0143	1.07	.0380	.0091	3.69	.1312	.0314	.0314	.0314	14.68	.5215	.1248	6		
7. Katali (Tag.) <i>Musa sapientum</i> Linn. var. <i>katali</i> Quis.	56.06	1.10	1.32	.0330	.0145	0.26	.0066	.0029	3.19	.0799	.0351	.0351	.0351	18.41	.4609	.2025	7		
8. Khai Pet (Siam) <i>Musa sapientum</i> Linn. var. <i>khai</i> Quis.	62.63	1.17	1.57	.0492	.0184	0.51	.0161	.0060	6.18	.1935	.0723	.0723	.0723	9.30	.2911	.1088	8		
9. Lacatan (Tag.) <i>Musa sapientum</i> Linn. var. <i>lacatan</i> (Blanco) Teodoro	61.19	1.04	2.02	.0541	.0210	1.19	.0320	.0124	20.17	.5406	.2098	.2098	.2098	28.28	.7578	.2941	9		
10. Latundan (Tag.) <i>Musa sapientum</i> Linn. var. <i>cinerea</i> (Blanco) Teodoro	67.85	0.96	1.83	.0547	.0176	1.71	.0510	.0164	6.98	.2084	.0670	.0670	.0670	26.25	.7838	.2520	10		

NITRIFYING EFFICIENCY OF SOILS ¹

JUAN G. TUCAY

INTRODUCTION

That microorganisms occur in the soil in enormous numbers is a well established fact. The transformation of the insoluble organic substances to soluble forms so they will be readily available for the plants has been attributed mainly to bacterial activities.

The process of nitrification may be defined as the conversion of ammonium salts or nitrogenous organic matter into nitrates by various forms of microorganic life. The rate of nitrification is an important criterion in measuring the crop-producing power of the soil. Bear (1929) showed that good drainage, frequent cultivation, adequate quantity of water, and warm temperature are essential to the production of nitrate in the soil. Excessive water or the absence of nitrogen tends to favor an anaerobic flora and may result in stopping the nitrification process. Kelly (1920) found that nitrification occurs in the soil in the presence of a rather high lime requirement.

Fraps (1920) in his work concluded that the quantity of nitrate produced in soils depends upon the quantity of organic nitrogen, the form of chemical combination, physical condition of the soil and the chemical composition of the soil. Javier (1931) also found that the nitrification process is influenced by soil type, topography, climate, vegetation, microbiological soil population and cultivation.

Review of literature

The nitrifying power of the soil has been generally claimed to be correlated with the fertility of the soil.

Alicante (1927) pointed out that nitrification is an index of crop production as evidenced by the soils from productive citrus orchards having a higher nitrifying power than soils from unproductive ones. Also the physical property of the soil has an important bearing on its nitrifying power.

¹ Thesis presented for graduation, 1932, with the degree of Bachelor of Science in Agriculture from the College of Agriculture, No. 337; Experiment Station contribution, No. 853. Prepared in the Department of Soils under the direction of Dr. Dionisio I. Aquino.

Noyes and Conner (1919) stated that in general the number of bacteria in an arable soil can be correlated with crop yield and the nitrifying capacity of the soil.

Brown and Aquino (1929) were of the opinion that rotation of crops has a direct correlation between the numbers and activities of organisms and the crop producing capacity of the soil. They claimed also that continuous cropping repressed the development of beneficial soil organisms.

Burgess (1918), Waksman (1932) and Erdman and Humfeld (1928) expressed the belief that the degree of nitrification, nitrogen fixation and soil reactions are correlated with the fertility of the soil.

Gainey (1917) and Gainey and Gibbs (1916) considered nitrification and bacteriological studies to have correlation with soil fertility and the cropping system.

Smith (1927) attributed the fluctuation of nitrate nitrogen in soil to be the result of the activity of soil microorganisms.

Sackett (1924) in his investigations justified the proposition that excessive nitrates present in the soil were the results from the combined actions of nitrogen-fixing, ammonifying and nitrifying organisms.

Kelly (1915) pointed out that pasture and forest lands not subjected to frequent tillage contain very small amounts of nitrates but fairly large quantities of ammonia. The inactive state of nitrification in uncultivated soils is not due to the absence of the nitrifying organisms or acidity. He further claimed that aëration and tillage stimulated nitrification and ammonification.

Pendleton, Brown and Smith (1929) showed that the addition of ammonium sulfate and various nitrogen fertilizers to the soil favored nitrification.

Pañganiban (1915) and Aragon (1918) concluded that different soils have different rates of nitrification even though they be chemically the same.

Javier (1931) stated that soil samples of the same type occurring in different areas differed in their nitrifying power.

Brown and Houghland (1929) considered the reaction of the soils to have an influence on the nitrification process.

Temple (1914) in his study of nitrification in acid soils found the rate of nitrification of ammonium sulfate to be smaller than when calcium carbonate was applied.

Objects of the present work

The objects considered and reported in this paper are: (a) To determine the nitrifying efficiency of soils under different systems of soil management; and (b) to determine the influence of soil water content and soil reaction together with topography, color, texture and structure on the nitrifying capacity of the soils.

Time and place of the present work

The actual work on the study of the nitrifying efficiency of soils was begun in April, 1931 and carried on to February, 1932, a period of almost eleven months.

The soil samples were collected from six lots of the Paliparan Estate on the Maquiling Forest Area. Sampling was done at intervals of three weeks during the whole period of the study.

Soil analyses were conducted in the Department of Soils Laboratory, College of Agriculture.

MATERIALS AND METHODS

The collected soil samples from the six lots, soil auger, soil bags, spatula, tumblers, electric oven, beakers, evaporating trays with two inches of sand in the bottom, filter papers, funnels, and distilled water were used.

The reagents used were: (a) phenoldisulfonic acid, (b) standard potassium nitrate solution, (c) normal copper sulfate solution, (d) solid calcium hydroxide, (e) solution or ammonium hydroxide (1:1), (f) stock solutions of ammonium chloride (NH_4Cl), ammonium sulfate $(\text{NH}_4)_2\text{SO}_4$, ammonium phosphate $(\text{NH}_4)_3\text{PO}_4$, 2 cc. of each being equivalent to 20 mgm. nitrogen (N).

The soil samples were collected according to the method suggested by Fred (1916).

Each sample was placed on a sheet of heavy Manila paper, thoroughly mixed, and spread out to dry in diffused daylight. After drying for two or three days the soil was thoroughly mixed, pulverized and passed through a one-millimeter mesh sieve.

The method for determination of moisture suggested by Fred and Waksman (1928) was followed in the determination of moisture in the soil.

Eight 100-gram portions of each of the soil samples were weighed in numbered tumblers and treated as follows: The first two samples served as checks. The other samples were treated as follows: To the second duplicate cultures, 2 cc. of ammonium chloride solution (NH_4Cl) equivalent to 30 mgm. nitrogen (N) were added. To the

third duplicate cultures, 2 cc. of ammonium sulfate $(\text{NH}_4)_2\text{SO}_4$ were also added. The last two samples were treated with 2 cc. of ammonium sulfate solution $(\text{NH}_4)_3\text{PO}_4$.

Both the checks and the treated cultures were incubated at room temperature as suggested by Waksman (1923a).

In the determination of the nitrate nitrogen contents of the cultures the standard phenoldisulfonic acid (colorimetric) method as suggested by Emerson (1927) was used. The results were tabulated and are on file in the Department of Soils, College of Agriculture.

EXPERIMENTS AND RESULTS

A partially forested area known as the Paliparan Estate from which the soils in this work were collected was divided into six lots.

Lot I is a cut-over area of 609 square meters. The whole lot is covered with six months old ratoons and seedlings of ipilipil (*Leucaena glauca* Linn.). The topography is rather sloping. The surface soil with a depth of from 10 to 15 centimeters is a residual clay loam. It is dark brown to grayish brown in color. The soil is heavy in texture and quite tight in structure.

Lot II is also a cut-over area (2 months old). It contains 1,115 square meters. Ratoons and young seedlings of ipilipil are found all over the lot. The surface soil having a depth of from 18 to 20 centimeters is clay loam of residual formation. It has a dark brown color, and the topography is moderately sloping. The soil appears to be friable.

Lot III is a caiñgin with an area of 2,340 square meters. The southern portion of the lot is rolling, and the western portion rather sloping. The surface soil is dark brown clay loam with a depth of from 15 to 18 centimeters. Upland rice was planted on this area in May, 1931 and the crop was harvested about the end of September. Then this lot was planted to corn. Both crops were cultivated and weeded.

Lot IV with an area of 2,150 square meters is a plowed caiñgin. During May this lot was planted to rice which was harvested in September. Corn was planted just after the rice was harvested. The field was cultivated by shallow plowing three weeks before and after planting each crop. This lot has a rolling topography. The surface soil is dark brown residual clay loam with a depth of 15 to 20 centimeters.

Lot V with an area of 538 square meters is covered with cogon (*Imperata cylindrica* Linn.). This lot is also rolling in topography.

The surface soil is from 18 to 20 centimeters deep, of residual formation and is a dark to dark grayish brown color.

Lot VI is covered by a six-year old growth of ipilipil trees. It has a rolling topography. The surface soil is from 15 to 20 centimeters in depth. In color it is from dark to dark brown. It is friable and loose in structure.

Except in color and structure the sub-soils of each of the lots is similar in physical characteristics to the surface soil. The color ranges from brown to reddish brown and the texture is heavier than that of the top soil.

The percentage of moisture and the nitrate nitrogen content of the soils together with the soil reaction and results of different treatments used in this experiment were tabulated and are on file in the Department of Soils, College of Agriculture.

DISCUSSION OF RESULTS

The effect of soil moisture on the nitrifying efficiency of soils

The results showed that there was an apparent variation of moisture content in the soils of the different lots, ranging from the lowest (36.36 per cent) for lot VI to the highest (47.28 per cent) for lot II. The other lots are intermediate, IV, I, III and V with moisture percentages increasing in the order in which they are named. This moisture variation may be due to the differences in texture and structure of the soil as affected by the difference in organic matter content of the soil owing to different types of soil management to which the lots have been subjected. Of the lots covered with ipilipil, lot II, the youngest cut-over area, gave the highest in percentage of moisture, while lot VI, with the lowest moisture percentage is the oldest cut-over area. Lot I, intermediate between the two, showed a percentage of water content midway between the lowest and the highest. Again, lot V (cogon), lot II (cañgin) and lot IV (plowed) varied in moisture content in descending order as they are named. Presumably, the youngest cut-over area contained a greater amount of organic matter than the other similarly treated areas because of the difference in their time of clearing. With respect to lots V, III and IV, their variation may be due to the difference in their vegetative cover, hence, the difference in their organic matter content. This difference may be accounted for by the fact that, other things being equal, the microbial activities differ in soils of different situations, different physical and chemical characteristics and different soil managements,

such as obtained in the lots in question. And this difference in microbiological action is bound to be reflected in the formation of nitrate nitrogen.

A study of the results of the moisture determination of each lot showed that for all the lots there was a gradual increase in the amount of moisture present in the soil in each lot from May to September. After September this moisture content began to decrease, evidently because of the differences in weather conditions during the time this work was conducted.

Nitrate nitrogen content of the soil studied

A seasonal variation in the nitrate nitrogen content of the soil in each lot was apparent, the basis of comparison being the soil nitrate content of the untreated samples as indicated by the different periods of sampling. Dividing the investigation period into three arbitrary seasonal series, the first series characterized by low moisture content comprises the samplings for the month of May; the second series characterized by medium moisture content comprises sampling from June to September; and the third series characterized by the highest moisture content comprises sampling from October to February. It is quite remarkable that for every lot, variation in the serial average nitrate contents runs the lowest for the first series, medium for the third series, and the highest for the second series.

Considering the nitrifying efficiency of the soils on the basis of the effect of application of ammonium salts; namely, ammonium chloride (NH_4Cl); ammonium sulfate $(\text{NH}_4)_2\text{SO}_4$; and ammonium phosphate $(\text{NH}_4)_3\text{PO}_4$, the greatest nitrifying power of the soil was accomplished with the use of ammonium phosphate, the next highest with the ammonium sulfate and the least with the application of ammonium chloride (NH_4Cl).

With respect to the reaction of the soils from each of the lots, it did not seem to show a very significant difference, the range being from 6.05 to 7.12 pH for lot I; from 6.00 to 6.83 pH for lot II; from 5.89 to 6.94 pH for lot III; from 5.62 to 6.52 pH for lot IV; from 5.70 to 7.00 pH for lot V; and from 5.91 to 7.14 pH for lot VI. That is to say, that the pH value of the soil in any of the lots in question, even when their averages were taken on the seasonal series basis, did not show any correlation with the nitrifying power of the untreated soil samples.

SUMMARY OF CONCLUSIONS

1. Studies were made on the nitrifying efficiency of soils representing six lots of the Paliparan Estate (a portion of the Maquiling

Forest Area) Los Baños, Laguna, as affected by the weather, soil moisture content and soil reaction.

2. The nitrate nitrogen content of the soils showed a seasonal variation as indicated by the averages of the three seasonal series covering the entire period of investigation. The highest nitrate content corresponded to the period of moderate moisture content, the second highest nitrate content to the period of highest moisture content and the lowest nitrate content to the period of lowest moisture content.

3. There was a distinct variation in moisture content of the six lots. This variation is presumed to be due to differences in the organic matter content of the lots which results from the varied types of soil management to which the lots were subjected.

4. The application of ammonium phosphate $(\text{NH}_4)_3\text{PO}_4$ and ammonium sulfate $(\text{NH}_4)_2\text{SO}_4$ stimulated the nitrifying efficiency of the soil as was shown by a considerable increase in the amount of nitrate formed. On the other hand, the ammonium chloride (NH_4Cl) treatment gave but a slight increase in lots II, III and IV, and an altogether negative result in lots I, V and VI.

5. Lot II planted to ipilipil (2 months old, the youngest of the cut-over areas) carrying the highest average moisture content, showed the highest nitrifying power in the check, as well as in the samples treated with the different ammonium salts mentioned above.

6. Lots III, I, VI and IV showed the next highest nitrate content, varying in amounts from lot III, the highest, to lot IV, the lowest. There was no correlation between the nitrate and moisture contents of these plots.

7. Lot V (cogon area) contained the least nitrate nitrogen content and was the poorest in nitrification.

8. The pH value of the different soils, being for the most part more or less near to neutrality, did not show a significant variation in its effect on the nitrifying power of the soils in question.

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A COMPARATIVE STUDY OF CORN AND MOLASSES AS BASAL FEEDS FOR SWINE ¹

DIODATI R. GOCHANGCO

This work is a continuation of a series of studies on carbonaceous feed stuffs that are available in many parts of the Philippines. The subject of the present study is the feeding value of molasses and corn for swine.

PAST WORK ON THE SUBJECT

Alcasid (1927) found in his experiment on certain fattening teeds for hogs that molasses-fed pigs gave a higher net gain than corn-fed pigs and that molasses-fed pigs gave the highest percentage of dressed weight.

Andouard (1901) claimed that cane molasses is superior to beet molasses for animal feeding on account of its low ash content. The ash content of cane molasses is 2.23 per cent and 11.45 per cent in beet molasses.

Brunnich (1924) states that the large amount of soluble salts of potash and lime and amides in molasses acts adversely on the digestion, and may cause scours unless fed in moderate quantities.

According to Bernard (1925) molasses should never be fed alone; water should be added as the vehicle for this product in the proportion of one part molasses to two or three parts of cold water. Furthermore, molasses should not be used to disguise damaged, moldy or soured food, which might develop toxic symptoms which would be wrongfully attributed to the molasses.

Cross (1925) concluded that the use of molasses permits the securing of a daily economy of 25 to 40 per cent on the ordinary cost of the ration and that it improves the health of the animal.

Cooran (1927) reported that when molasses is fed to pigs it should be used only as an appetizer and laxative; if fed in excess it may result in the death of the animals.

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Frederiksen (1896) stated that molasses can be advantageously fed to pigs weighing over fifty pounds.

Faye and Frederiksen (1897) observed in their investigation that less feed was required per pound of gain, and the gains in weight were more economically made when the grain was fed without molasses than when both were fed, but that when the molasses fed animals were slaughtered the meat was excellent.

According to Giron (1922) a much greater proportion of cane molasses than of beet molasses can be used in compounding feeds, because the salts of the former do not have as laxative effect as those of the latter. He recommended as the best molasses feeds those in which molasses is mixed with the same quantity of various dry substances in a pulverulent state.

Hunter (1917) from his experiment on the value and economy of molasses as a substitute for corn in the brood sow ration found that low-grade molasses was not a satisfactory substitute for corn even at a lower cost; and that grain rations supplemented with molasses produced greater gain than where no molasses was used or where molasses was substituted wholly for grain.

Lindsey, Holland and Smith (1907) observed that pigs can take comparatively large amounts of cane molasses without ill results, but that it is necessary to begin with a small amount and increase it a little every few days. Molasses when used for feeding pigs should be mixed with feed reasonably rich in protein.

Meisel (1897) in comparing sugar cane molasses with starch as part of a ration, stated that sugar, because of some secondary effect, hindered slightly the gain in muscular and fatty tissue.

OBJECT AND TIME OF PRESENT WORK

The object of this study was to determine and compare the feeding value of molasses and corn as basal feed (*a*) for growing pigs, and (*b*) for gilts for breeding purposes.

The work was begun June 22, 1930 and was closed on January 18, 1931, thus covering a period of about seven months.

MATERIALS AND METHOD

Materials

Animals. Twenty-one Berkjala weanlings were used in experiment I. Fourteen gilts were used in experiment II. The weanlings consisted of fifteen castrated males, three females and three uncastrated males.

Feeds and rations used. The rations used in experiment I were as follows:

	<i>Lot I</i>	<i>Lot II</i>	<i>Lot III</i>
Corn	20 parts	10 parts	0
Molasses	0 "	10 "	20 parts
Rice bran	60 "	60 "	60 "
Copra meal	18 "	18 "	18 "
Shrimps	2 "	2 "	2 "
Total	100 parts	100 parts	100 parts

The rations for experiment II were:

	<i>Lot I</i>	<i>Lot II</i>
Corn	20 parts	0
Molasses	0 "	20 parts
Rice bran	60 "	60 "
Copra meal	18 "	18 "
Shrimps	2 "	2 "
Total	100 parts	100 parts

Table I shows the analysis of corn and molasses used in the study.

TABLE I
Showing the chemical analysis of corn and molasses

FEEDS	MOISTURE	PROTEIN	FAT	ASH	CRUDE FIBER	CARBOHY-DRATES	SUCROSE	CALORIES PER 100 GRAMS
Corn (1928)	13.41	7.56	2.79	1.78	3.19	71.27	.....	350
Cane molasses ^a	33.45	1.63	0.48	8.82	.....	55.62	38.59	240

^a Analyzed in the Department of Agricultural Chemistry, College of Agriculture, University of the Philippines.

Minerals used. To every 100 kilograms of all feed mixtures one kilogram of equal parts of common salt and corn-cob charcoal was added.

Method

Allotment of pigs. Experiment I consisted of three lots with seven pigs to each lot. The pigs in each lot consisted of five barrows, one boar, and one gilt. In experiment II two lots of seven gilts each were used. The weight and condition of the pigs were considered in distributing the pigs in the different lots.

Duration of the experiment. Experiment I was carried for 210 days divided into three 70-day periods. Experiment II was carried for 70 days.

Weighing. Each pig was weighed on three consecutive days at the beginning of the experiment and the average of the three weights was taken as the initial weight. The final weight was found in like manner.

System of feeding. In both experiments the pigs were fed twice daily between 5:00 and 6:00 a. m. and between 4:00 and 5:00 p. m. They were given all they could readily consume, except toward the latter part of experiment II. At this period, the pigs in both lots began to show a marked tendency to fatten so a limited ration was given. For the molasses lots, just before feeding, a sufficient amount of molasses was added to the ration of each lot to make up the proportion called for.

After feeding in the morning the pigs in experiment I were driven into one of the one-fourth hectare grass pastures and the pigs in experiment II into another grass pasture lot. From September 7, 1930 until about the end of the month the animals in experiment I were turned into a good pasture of mungo and were allowed to stay there over-night. Beginning with October they were again turned on grass pasture. On October 12 they were turned into a new soy-bean pasture. This pasture lasted them until October 27 when they were turned into the grass pasture. To supplement the depleted pasture the animals were given from 5 to 8 kilograms of camote soilage in each lot until the close of the test. The pigs in each lot were trained to go to their respective pens at feeding time.

Bathing and watering. At noon the pigs were driven from the pasture into the hog house to wallow, or the hose was turned on them. They were given water to drink. When the weather was good they were returned to the pasture for the night; when the weather was bad, they were kept inside the hog house.

RESULTS

Experiment I

First 70-day period. Table 3 summarizes the results obtained during the first 70 day period of experiment I. It may be seen that lot III (molasses) made the most rapid rate of gain with lot II, second and lot I, third. Lot III consumed the least amount of feed to make a kilogram gain, hence, made the most economical gain; lot II was second and lot I, third.

Second 70-day period. During this period, lot II made the fastest rate of gain, lot III, second, and lot I, third. Lot II consumed the least amount of feed to make a kilogram gain, lot III was second and lot I, third. Lot I made the most expensive gain, lot II was second and lot III made the most economical. (See table 2.)

Third 70-day period. Lot I made the best rate of gain, lot II the second best and lot III was third. Lot I consumed the least amount of feed to make a kilogram gain, lot II was second and lot III was the highest. However, lot III made the lowest or most economical gain; lot II was in between. Animals in the molasses lot looked much better as show animals than those in the corn lot.

210-day period. Combining the partial results obtained from the three 70-day periods into one whole 210-day period, the data show that the corn lot made an average daily gain of .2233 kilogram, the molasses lot, .2246 kilogram, the corn-molasses lot, .2322 kilogram; practically all made the same rate of gain. (See table 2.)

Lot I (corn) took the shortest time to eat their meals. Lot II (molasses and corn) was second in length of time in consuming their feed. They always had a good appetite, except during the first weeks of the test when they did not seem to like their feed very well. Lot III (molasses) took the longest time to eat their meals and did not relish their feed as much as did the other two lots. At the close of the test, they looked much fatter than the pigs in lot I.

Experiment II

Lot I made an average daily gain of .3466 kilogram, lot II, .2821 kilogram.

In lot I it took 5.5658 kilograms feed to make a kilogram gain, and in lot II, 6.712 kilograms. To produce a kilogram gain in lot I the feed cost .3122 centavos and in lot II, .3472 centavos. The animals in lot II were much fatter than those in lot I and were good for show purposes.

Lot I (corn) took the shortest time to eat their meals. Gilt 397 farrowed August 25, 1930. Lot II (molasses) took the longest time to eat their feed. During the first few days they coughed a good deal at feeding time and sometimes stood as if drunk or drugged. Some of the animals would stop feeding and lie down for some time then go back to their feed. As the test progressed they gradually behaved as the pigs in the other lot in the manner of feed-

ing. Animals in this lot appeared to be fatter than those in the other lots even up to the end of the experiment. Animals Nos. 411 and 439 farrowed on July 28 and August 25, 1930, respectively.

DISCUSSION OF RESULTS

Experiment I.

First 70-day period. Table 2 shows that lot I (corn) made an average daily gain of .1663 kgm.; lot II (corn-molasses), .1916 kgm.; and lot III (molasses), .1927 kgm. In this respect, the lot with molasses in their rations were 15 per cent more efficient than the corn lot. However, a statistical study of the average daily gains, from the standpoint of the probable error of the means and coefficient of variability, indicates that there was no significant difference. The mean daily gains and the corresponding probable error by lots were: Lot I, 11.64 ± 5.93 kgm.; lot II, $13.41 \pm .7777$ kgm.; lot III, 13.48 ± 1.543 kgm. The mean difference between the daily gains in lot I and lot II together with its probable error was 1.77 ± 5.981 kgm.; between lot I and lot III was 1.84 ± 6.128 kgm.; and between lot II and III was $.07 \pm 1.728$ kgm.

From the standpoint of feed required to make a given unit of gain, lot I needed 4.552 kgm. feed to make a kgm. gain, lot II, 3.912 kgm. and lot III, 3.819 kgm. The difference was 15 per cent in favor of the molasses lots.

As the molasses cost only half as much as the corn and as both have practically the same feeding value, weight for weight, there is a marked difference between the cost of the gains made by the lots. In lot I it took P.2552 worth of feed to make a kilogram gain; in lot II, P.2132, and in lot III, P.2013, thus giving a difference of about 5 centavos saved per kilogram gain in favor of molasses. Therefore, when the market price of molasses is lower than that of corn, molasses should be preferred to corn for this class of hogs.

Second 70-day period. In the second period of the test (see table 2) lot I made an average daily gain of .2138 kgm., lot II, .2310 kgm., and lot III, .2200 kgm. The corn lot remained slightly the poorest, with lot II very slightly above lot III. Subjecting the difference to statistical test it was found to be of no significance. The mean daily gains and the corresponding probable error by lots were; lot I, $14.971 \pm .155$ kgm., lot II, $16.171 \pm .416$ kgm., and lot III, 15.40 ± 1.322 kgm. The difference of the mean between the daily

gain in lot I and lot II was $1.200 \pm .0444$ kgm.; and between lot I and lot III, $.429 \pm 1.331$ kgm.; and between lot II and III, $.77 \pm 1.865$ kgm.

Lot I required 3.903 kgm. feed for a kgm. gain, lot II, 3.577 kgm., and lot III, 3.72 kgm. Lot II appeared to be the best with lot III, second. The difference was not much and probably was not due to the difference in rations under test.

In lot III the cost in feed to make a kilogram gain was ₱.1884, in lot II, ₱.2064, and in lot I, ₱.2529.

All the lots made more economical gains in this period than in the first, because of better pasturage at this time, as the rainy season was advanced. On September 9, 1930 the pigs were turned into a mungo pasture until about the end of the month. On October 12, 1930, they were turned into a soybean pasture which lasted them until October 27.

Third 70-day period. It may be noted in table 2 that the pigs in lot I made an average daily gain of .2931 kgm., lot II, .2825 kgm., and lot III, .2633 kgm. The corn lot, therefore, made the most rapid gain, assuming the lead from the second week and keeping it till the close of the experiment. Lot II and lot III interchanged places at intervals. The three lots, however, never varied widely, as may be seen in table 2.

Statistical study of the differences in the results obtained showed again that there was no significant difference. The mean daily gains and the corresponding probable error by lots were; lot I, 20.51 ± 2.061 kgm.; lot II, $19.77 \pm .680$ kgm.; and lot III, $18.42 \pm .791$ kgm. The mean difference between the daily gains in lots I and II was $.743 \pm 2.170$ kgm. and between lots I and III, 2.085 ± 2.207 kgm. and between lots II and III, $.342 \pm .1524$ kgm.

Lot I took 3.374 kgm. feed to make a kgm. gain in weight, lot II, 3.418 kgm. and lot III, 3.550 kgm. In cost of feed to make the same gain, lot I required ₱.1986 worth of feed, lot II, ₱.1804 and lot III, ₱.1761.

All the lots showed improvement in ability to decrease the amount of feed required to make gains. This improvement is probably the result of the pigs being turned into pasture all the time; in grass pasture part of the time, and mungo and soybean pasture the rest of the time; besides, they were given 5 to 8 kgm. camote soilage daily, amounting to 490 kgm., or more, during the period.

The three-70-day periods combined. In combining the partial results obtained from the 210-day feeding test the notable point obtained is that the rate of gains made, and the amount of feed re-

quired by each of the three lots were practically the same. Thus the corn lot made an average daily gain of .2244 kgm.; the molasses lot, .2246 kgm.; the corn-molasses lot, .2350 kgm. The corn lot required 3.83 kgm. feed to make a kgm. gain; the molasses lot, 3.70 kgm.; and the corn-molasses lot, 3.61 kgm. The difference in the cost of feed to produce a kgm. gain was always in favor of molasses owing to the difference in market price between corn and molasses, the molasses costing only about half as much as the corn.

Another outstanding result which became more evident as the feeding trial advanced was the uniformly fine, smooth and sleek appearance of the pigs in the molasses lot. They looked much better for show purposes than those in the corn lot.

Experiment II

70-day period. The gilts in the corn lot made gains faster and more economically than those in the molasses lot. The corn lot made an average daily gain of .3446 kgm. and the molasses lot made .2821 kgm. The corn lot required 5.5658 kgm. feed to make a kgm. gain, the molasses lot, 6.712 kgm. It appears that the corn ration is decidedly superior to the molasses ration. A statistical study of the difference in the rate of gains made by the two lots, however, indicates that the difference is not significant.

One gilt in each lot farrowed about the same time; gilt No. 397 in lot I farrowed August 25, 1930. In lot II, gilt No. 439 farrowed August 25, 1930 and gilt No. 411 farrowed July 28, 1930. To determine as to whether or not these animals had materially influenced the relative results of the two lots as a whole, the average daily gain of the unbred gilts in the two lots was taken; those of lot I gave an average daily gain of .3412 kgm. and lot II, .3122 kgm. The relation of the two lots, as may be noted, remained the same. One important factor which markedly brought down the total average gain of the molasses lot was the loss in weight of gilt No. 411 which farrowed on July 28, 1930 and suckled her litter the rest of the feeding period. If we add the gains made by the suckling pigs to the gains made by the seven animals of the same lot the results would be about the same. Gilts No. 979 and Lady Grove also of lot II came in heat during the last week which occasioned some loss in the gains made and a marked drop in the growth curve of the lot.

Statistical study of the difference shows that there was no significant difference in the results obtained. The mean daily gains and the corresponding probable error by lots were: lot I, $24.057 \pm$

1.909 kgm. and lot II, 18.271 ± 2.477 kgm. The difference of the mean between the daily gains in lots I and II was 5.786 ± 2.963 kgm.

The gilts in lot II, as a whole, appeared fatter, more refined and smoother than the corn lot. This result corroborates the result obtained in experiment I.

SUMMARY OF CONCLUSIONS

1. In the mixture of feeds used in these experiments, for growing pigs and gilts one part of molasses was found to be equal to one part of corn in feeding value.

2. Molasses should be substituted partly or wholly for corn, especially when the latter becomes scarce or the price high.

3. To prepare an animal for show purposes, molasses appears to be a better feed than corn, as it imparts more readily plumpness, smoothness and refinement in the general appearance of the animal.

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TABLE 2
Showing summary of results in each lot in experiment I
First 70-day period

RATION :	CORN RICE BRAN COPRA MEAL SHIMES MOLASSES	LOT I			LOT II			LOT III		
		20 PARTS	60 "	18 "	2 "	0 "	70 days	10 PARTS	60 "	60 PARTS
Number of pigs		7	7	7	7	7	7	7	7	7
Duration of experiment		70 days	70 days	70 days	70 days	70 days	70 days	70 days	70 days	70 days
Av. initial weight		15.10 kgm.	15.10 kgm.	15.10 kgm.	15.10 kgm.	15.10 kgm.	15.11 kgm.	15.11 kgm.	15.11 kgm.	15.11 kgm.
Av. final weight		26.74 "	26.74 "	26.74 "	26.74 "	26.74 "	28.60 "	28.60 "	28.60 "	28.60 "
Av. gain per pig		11.643 "	11.643 "	11.643 "	11.643 "	11.643 "	13.486 "	13.486 "	13.486 "	13.486 "
Av. daily gain per pig		0.1663 "	0.1663 "	0.1663 "	0.1663 "	0.1663 "	0.1916 "	0.1916 "	0.1916 "	0.1916 "
Feed consumed per pig		53.00 "	53.00 "	53.00 "	53.00 "	53.00 "	51.50 "	51.50 "	51.50 "	51.50 "
Cost of grain consumed per pig		₱2.9714	₱2.9714	₱2.9714	₱2.9714	₱2.9714	₱2.7143	₱2.7143	₱2.7143	₱2.7143
Av. daily gain per pig		.7571 kgm.	.7571 kgm.	.7571 kgm.	.7571 kgm.	.7571 kgm.	.7357 kgm.	.7357 kgm.	.7357 kgm.	.7357 kgm.
Grain feed consumed to produce 1 kgm. gain		4.552 "	4.552 "	4.552 "	4.552 "	4.552 "	3.919 "	3.919 "	3.919 "	3.919 "
Cost of grain to produce 1 kgm. gain		₱0.2552	₱0.2552	₱0.2552	₱0.2552	₱0.2552	₱0.2132	₱0.2132	₱0.2132	₱0.2132

RATION :	CORN RICE BRAN COPRA MEAL SHIMES MOLASSES	LOT I			LOT II			LOT III		
		20 PARTS	60 "	18 "	2 "	0 "	70 days	10 PARTS	60 "	60 PARTS
Number of pigs		7	7	7	7	7	7	7	7	7
Duration of experiment		70 days	70 days	70 days	70 days	70 days	70 days	70 days	70 days	70 days
Av. initial weight		26.74 kgm.	26.74 kgm.	26.74 kgm.	26.74 kgm.	26.74 kgm.	28.51 kgm.	28.51 kgm.	28.51 kgm.	28.51 kgm.
Av. final weight		41.71 "	41.71 "	41.71 "	41.71 "	41.71 "	44.69 "	44.69 "	44.69 "	44.69 "
Av. gain per pig		14.97 "	14.97 "	14.97 "	14.97 "	14.97 "	16.17 "	16.17 "	16.17 "	16.17 "
Av. daily gain per pig		0.2139 "	0.2139 "	0.2139 "	0.2139 "	0.2139 "	0.2310 "	0.2310 "	0.2310 "	0.2310 "
Feed consumed per pig		58.43 "	58.43 "	58.43 "	58.43 "	58.43 "	57.79 "	57.79 "	57.79 "	57.79 "
Cost of grain consumed per pig		₱3.790	₱3.790	₱3.790	₱3.790	₱3.790	₱3.324	₱3.324	₱3.324	₱3.324
Av. daily gain per pig		.8347 kgm.	.8347 kgm.	.8347 kgm.	.8347 kgm.	.8347 kgm.	.8256 kgm.	.8256 kgm.	.8256 kgm.	.8256 kgm.
Grain feed consumed to produce 1 kgm. gain		3.903 "	3.903 "	3.903 "	3.903 "	3.903 "	3.574 "	3.574 "	3.574 "	3.574 "
Cost of grain to produce 1 kgm. gain		₱0.2531	₱0.2531	₱0.2531	₱0.2531	₱0.2531	₱0.2057	₱0.2057	₱0.2057	₱0.2057

Second 70-day period

Third 70-day period

	70 days	7	70 days	7	70 days	7
Number of pigs						
Duration of experiment						
Av. initial weight	41.71	kgm.	44.69	kgm.	43.86	kgm.
Av. final weight	62.23	"	64.46	"	62.29	"
Av. gain per pig	20.51	"	19.77	"	18.43	"
Av. daily gain per pig	0.2930	"	0.2824	"	0.2633	"
Feed consumed per pig	69.21	"	67.57	"	65.43	"
Cost of grain consumed per pig	₱3.8671		₱3.5657		₱3.2443	
Av. daily grain per pig .....	.9888	kgm.	.9653	kgm.	.9347	kgm.
Grain feed consumed to produce 1 kgm. gain	3.374	"	3.418	"	3.550	"
Cost of grain to produce 1 kgm. gain	₱0.1885		₱0.1804		₱0.1760	

Summary of results in experiment I with the three 70-day periods combined

	210 days	7	210 days	7	210 days	7
Number of pigs						
Duration of experiment						
Av. initial weight	15.10	kgm.	15.10	kgm.	15.11	kgm.
Av. final weight	62.23	"	64.46	"	62.29	"
Av. gain per pig	27.129	"	49.357	"	47.171	"
Av. daily gain per pig .....	.2244	"	.2350	"	.2246	"
Grain feed consumed per pig	180.64	"	178.27	"	174.29	"
Cost of grain consumed per pig	₱10.63		₱9.75		₱8.83	
Av. daily grain per pig	0.8602	kgm.	0.8489	kgm.	0.8299	kgm.
Grain feed consumed to produce 1 kgm. gain	3.833	"	3.612	"	3.695	"
Cost of grain to produce 1 kgm. gain	₱0.2256		₱0.1975		₱0.1872	

TABLE 3

Showing summary of results in each lot in experiment II during the first 70-day period.

	RATION: CORN RICE BRAN COPRA MEAL SHRIMPS MOLASSES	LOT I		LOT II	
		20 PARTS	0 PARTS	60	18
		18	"	18	"
		2	"	2	"
		0	"	20	"
Number of pigs		7	7	7	7
Duration of experiment		70 days	70 days	70 days	70 days
Av. initial weight		59.77	kgm.	59.64	kgm.
Av. final weight		88.83	"	77.91	"
Av. gain per pig		24.057	"	18.271	"
Av. daily gain per pig		0.3437	"	0.2610	"
Grain feed consumed per pig		134.29	"	132.57	"
Cost of grain consumed per pig		P7.5328	"	P6.9857	"
Av. daily grain per pig		1.9184	kgm.	1.8939	kgm.
Grain feed consumed to produce 1 kgm. gain		5.5822	"	7.2558	"
Cost of grain to produce 1 kgm. gain		P0.3131	"	P0.3823	"

ABSTRACT¹

A preliminary study of the characteristics of the different varieties of tobacco in the College culture. TITO A. YOTOKO. (*Thesis presented for graduation, 1930, with the degree of Bachelor of Science in Agriculture from the College of Agriculture No. 339; Experiment Station contribution No. 855.*)—The author used 40 varieties of tobacco, 12 imported, 7 hybrid and 21 native varieties.

The objects of the investigation were (1) to study the characters of each variety of tobacco grown in the College cultures; (2) to determine which of these varieties are desirable for propagation; and (3) to discover which of the varieties appearing under different native names really belong to the same variety.

Seeds of each variety were sown in separate boxes, and the young plants were pricked at the age of three weeks and transplanted in plots having an area of 100 square meters each.

The results show that of the forty varieties used only seven varieties had their lowest standard leaves. Twenty of the varieties used suckered out. Four varieties had smooth leaf surface. Seven varieties had naked petioles. Nine varieties had drooping leaves.

Conneticut Havana, Improved Gold Leaf, Texas Cuban and Bonanza, seemed to have good leaves for wrapper purposes.

Those varieties good for fillers and binders are Tirona Hybrid, Hybrid Nos. 1, 2, 3 and 4, Indian, Repollo, Dammao Broadleaf, San Juan Batec, Alafug, Bahia, Morada, Gapan and Romero.

Many varieties under the same name but from different localities differed from one another when planted under Los Baños conditions.

Varieties Tirona Hybrid, Hybrid Nos. 1, 2 and 7, Sterling, Dammao Broadleaf, Bonanza, N-54, Banuang and Bahia mature early. Varieties Sumatra, Florida Dumatra, Indian, San Juan Batec, Angadanan, Romero, and Alafug mature late.

¹ Abstract prepared as part of required work in English 3a, College of Agriculture.

Broadly considered, tobacco grown in the College of Agriculture may be segregated into distinct groups; namely, wrapper, binder and filler, naked petiole, winged petiole, early and late maturing varieties.

Other important distinctions between the different varieties studied are; ability to produce suckers and position of the leaves.

—*Abstract by Numeriano L. Cuevas.*

CURRENT NOTES

The question of growing tomatoes in Jamaica for export is exciting much attention, this fruit being very popular and in great demand all the year round, the prices are comparatively good in the winter time, and it is then that there is a possible chance for Jamaica to enter the market especially in Canada and Great Britain.

—*The Journal of The Jamaica Agricultural Society* June, 1931.

Lady Pride Pontiac Lieuwkje, a registered Holstein cow owned by F. E. Murphy, publisher of *The Minneapolis Tribune*, has broken the world's record for combined milk and butter in a 365 day test just completed.

This cow produced 35,626 pounds of milk and 1483 pounds of butter in the year test. The dam of Lady Pride, while not a world's champion, ranked as one of the highest two-year olds of her time with a record of 860 pounds of butter and 20,825 pounds of milk, and was a granddaughter of K. P. Lilith Clothilde, a former world's champion with 1043 pounds of butter and 22,229 pounds of milk as a four-year old.

—*Minneapolis Tribune*, July, 1932.

The Bureau (Agriculture) slogan is a threefold one—"Better Farming, Better Business, and Better Living"—and it was long ago realized that to achieve the third of these objects it was necessary to include farm womenfolk as members and to cater for their needs.

The programme for the women's session at the annual conference was a comprehensive one, and included talks and demonstrations on such subjects as use of foodstuffs, millinery, dressmaking, gardening, care of the teeth, physical culture, health matters, and an address on racial hygiene.

—*Agricultural Gazette of N. S. W.*, September 1, 1932.

The Wyoming Collegiate Chapter of Future Farmers of America was recently organized at the University of Wyoming. Its purpose is to promote a better understanding of the F. F. A. and the duties of the local adviser. The membership consists of teacher-training students, with former F. F. As. now enrolled in college as associate members.

—*Agricultural Education*, August, 1932.

Versatile enough to delve into medical as well as aeronautical science, Col. Charles A. Lindbergh, famous flyer, recently attained new distinction as inventor of an improved type of centrifuge for preparing blood corpuscles in research tests. His brief announcement of the device to the scientific world was the first public revelation that for several months he had been quietly assisting Dr. Alexis Carrel, noted experimenter of the Rockefeller Institute for Medical Research, in tests on tissue culture and the transplantation of organs. Colonel Lindbergh's new invention separates and washes blood corpuscles by whirling a vessel containing the fluid. In his centrifuge, Lindbergh has demonstrated that the washed blood corpuscles are uninjured and are therefore available for scientific study.

—*Popular Science Monthly*, July 1932.

Boys are showing more and more interest in home economics courses, and an increasing number of schools are putting in special courses for boys or are revising parts of their home economics program to suit their needs.

A boy from a cooking class in the Arsenal Technical Schools is making "pin money" by baking graham cracker pies after school and on Saturdays. The report says he is kept busy filling his orders.

—*Practical Home Economics*, August, 1932.

Fully 75 per cent of all the land in cultivation in the United States is affected in some degree by erosion. The injury is much more serious, of course, in some sections than others.

It takes nature at least 400 years to build 1 single inch of the priceless topsoil of some of our important types of farm land, as for example the Shelby loam of Missouri and Iowa, an important type of Corn Belt land. It takes just seven years under continuous corn in northern Missouri, for 1 inch of the Shelby loam to wash off land

having a slope of about 4 feet in a hundred, and only one year to remove the same depth from land sloping 8 feet in a hundred—this by actual measurement of the soil washed off the slopes. No business can stand such losses.

The plant food removed from the fields and pastures of the United States every year by erosion is at least twenty-one times more than that removed by the crops harvested. That taken by crops can be restored in the form of fertilizer, but that taken by erosion can not be restored, because this malevolent process takes the whole body of the soil—plant food and all. Land impoverished strictly by plant-food depletion, as sometimes results from continuous growing of the clean tilled crops, is not worn-out land; the only worn-out land we have is that which has been so badly washed that it would be entirely futile to undertake to reclaim it. *H. H. Bennett, Soil-Erosion Specialist U.S.D.A.*

Quoted in *Tennessee Horticulture*, March 15, 1932.

COLLEGE AND ALUMNI NOTES

Professor and Mrs. Willard G. Bleyer accompanied by Mr. Eulogio Rodriguez of the Philippine Library were Campus visitors, October 18. Professor Bleyer is head of the School of Journalism, University of Wisconsin. He gave an informal talk to the students in the Auditorium. He told of the improvements throughout the Islands since his former visit some years ago. He also emphasized that agricultural production is no longer the great problem but distribution of agricultural products. This question is an international one and of tremendous importance.

Dr. Richard Woltereck, Professor of Zoölogy in the University of Leipzig, and Director of the Biological Station at Seeon, Bavaria, who has been in the Philippines and Netherlands East Indies since February studying the life of fresh water lakes, delivered, as guest lecturer in the University of the Philippines, a series of three lectures in the College Auditorium. On October 17, the subject was "What the problem covers and how it can be solved"; on October 19, "Unique inhabitants of islands and lakes (endemism); and on October 20, "Reading the past in present living forms".

From *The Malayan Agricultural Journal*, June, 1932.

"The third edition of this book, *The Coconut* by Edward [Edwin] Bingham Copeland, forms a comprehensive compilation of useful facts concerning the coconut palm, derived from many years of scientific observations in the Philippine Islands and aims at providing information of practical utility for the planter in a readable and concise form.

This aim has been fully achieved....

The book is couched in plain straight-forward language, eminently readable and should be a welcome addition to every planter's book shelf."

Mr. Gregorio Francisco, '17 and Dr. Felipe T. Adriano, '19 accompanied by Mr. Luis G. Miranda, Plant Superintendent of Magnolia Dairy Products, visited the College on October 20. Mr. Miranda was interested in the methods used by the Department of Animal Husbandry in the manufacture of native soft cheeses.

Doctors Santiago Y. Rotea and Estefano Farinas, both of the Bureau of Animal Industry, were recent College visitors. Doctor Rotea was interested in looking into our dairy work. Doctor Farinas' interest was in feeding. He is collecting formulae of successful rations in use by various animal feeders.

Dr. V. C. Calma of the Department of Agronomy attended the annual meeting of the technical assistants in Luzon of the Philippine Sugar Association held on September 28-30, 1932 in Manila and in Canlubang. Prof. R. H. King of the Sugar Technology Division and Mr. E. F. Roldan of the Department of Plant Pathology attended the meeting in Canlubang. Professor King read before the meeting in Canlubang a paper entitled "Methods of Sugar Distribution and Methods of Calculating Field Yields."

Chanticleer, *The Modern Poultryman*, reprinted with acknowledgments, in its September, 1932 issue an article on "Increase your profits by culling the flock" by Conrado B. Uichanco published in the June, 1932 issue of *The Philippine Poultry Journal*. *The Indian Poultry Gazette* reprinted in its September, 1932 number an article on "The relation between animal husbandry and veterinary science" by Dr. M. Manresa, Assistant Professor of Animal Husbandry pub-

lished in May, 1932 of *The Philippine Poultry Journal*. Dr. F. M. Fronda, '19 is founder and enterprising editor of *The Philippine Poultry Journal*.

The seventy-seventh meeting of the Los Baños Biological Club was held on Thursday, October 27, 1932, at 7:30 p. m. in the Poultry Husbandry lecture room of the College of Agriculture, Los Baños, Laguna.

The following papers were read and discussed:

"A brown bark rot of cacao trunk" by Dr. G. O. Ocfemia and Mr. Martin S. Celino. Paper read by Mr. Celino.

"Effects on hatchability of holding eggs in a low temperature" by Dr. F. M. Fronda and Mr. Pascual N. Andres. Paper read by Doctor Fronda.

The following students received marks of distinction at the close of the first semester of the academic year, 1932-33, based on the final ratings in October:

RANK	NAME	AVERAGE RATING	ACADEMIC LOAD	CLASS
1st	Komkris, Thuan	1.44	18	4th Year, B.S.A.
2nd	Demetrio, Jose K.	1.57	19	1st Year, B.S.A.
3rd	Flores, Felix de Leon	1.68	22	2nd Year, B.S.S.T.
4th	Flor-Cruz, Cenon	1.90	22	2nd Year, B.S.S.T.
5th	Balasico, Basilio M.	1.98	22	1st Year, B.S.A.
6th	Ortiz, Ponciano	2.00	16	4th Year, B.S.A.

The average rating was computed by multiplying the final rating obtained by the student in each course by the number of units carried by such course and dividing the sum of the products by the total number of units carried by the student.

Only students carrying regular loads (minimum of 15 units for working students and 20 units for regular students) were considered.

The academic loads of Thuan Komkris and Ponciano Ortiz as given exclude credits on thesis.

Mr. Feliciano M. Clara, '20 B.Agr. returned recently from four years study at Cornell University, where he received degree of Ph.D. last June. Doctor Clara returned *via* Europe. He is now with the Bureau of Plant Industry.

Miss Mamerta Manahan and Mr. Galicano Ilagan were married on October 1, 1932, at Batangas. Miss Manahan is assistant in chemistry and pharmacist at the College Infirmary and Mr. Ilagan is a member of nursing staff of Infirmary.

In extending wishes for all happiness to Mr. and Mrs. Ilagan, we express the hope that the Campus will long be their home—for without the gracious presence and the rich sympathetic voice of "Our Miss Manahan," the Campus sky would be a paler blue, the sunshine a paler gold.

On October 8, Dr. N. B. Mendiola, Head of the Department of Agronomy gave the fourth of the series of travelogues being given under auspices of the Christian Social Center. Doctor Mendiola spoke on Java, illustrating his description with photographs projected on the screen. He emphasized the agricultural phase, as during his year in Java he was engaged in the study of the methods followed in general farming, but more especially those in the large experiment stations.

Mr. E. M. Bautista of the Department of Engineering was the fifth travelogue speaker. On October 22, he took his audience to the salmon canneries in southeast Alaska. As in his student days Mr. Bautista worked in one of these canneries he made the trip most realistic. Photographs projected on the screen aided making the talk real.

Basunie Saropie of Sumatra added to the pleasure of the evening with two Sumatran dances. One, in which he carried two lighted candles, was of particular interest and grace. This dance was scheduled for the talk on Java, but Mr. Saropie was absent that evening on an investigation trip.

On October 24, Miss Victoria B. Mendiola '30 B.S.A. and Mr. Leon R. Ela were married. Miss Mendiola was the first Filipino woman to graduate from a college of agriculture. She also has the distinction of being the first Filipino woman plant pathologist. Since her graduation she has been graduate assistant in the Department of Plant Pathology. She has done considerable research and published several articles. Mr. Ela is herbarium assistant in the same department.

Through the courtesy of the Los Baños Chapter of the Rizal Center fraternity and some of the leading musical members of the Manila Chapter a delightful concert was given in the Center on the evening of October 22. The violin solos by Mr. Ernesto Vallejo, of the Conservatory of Music faculty, as always, gave the supreme pleasure that only true artists such as Mr. Vallejo and the pianist, Mr. Julio Esteban Anguita can give.

Mr. Juan Padilla, B.Agr. '32 (awarded Baker Memorial Scholarship), who is now in charge of the poultry projects of Mrs. J. J. Elizalde in Baguio writes to Doctor Fronda of his trials and success. Apparently, Mr. Padilla as an employee is the same plucky, plodding, careful worker he was as a student. He says his life is that of poultryman, "no Sundays, no holidays", works day and night. He is in charge of the largest incubator in the Islands, brooder and growing chickens. He writes that roup, cold, diarrhea and chicken pox are apparently his friends, as these chick troubles are not known in his flocks. He has two helpers, a woman who helps in the cleaning of the incubator and brooder and a young agricultural high school graduate. But Mr. Padilla is strictly on the job himself.

Mr. Olimpio B. Garcia a graduate assistant in chemistry resigned to accept a position with the Bakau Kenya Extract Plant Company, Ltd. at Sandakan, British North Borneo. The products of this company are dyeing and tanning materials. Before going to Sandakan Mr. Garcia will work with the Philippine Cutch Corporation of Zamboanga for three months for training and experience.

Mr. Honorio Samonte, B.S.A. '31, writing from Estancia, Iloilo, informs Doctor Fronda that he is introducing our famous Los Baños Cantonese chickens in that part of Iloilo. Judging from the letterhead of his letter, Mr. Samonte is running a poultry and fruit farm in Estancia.

Mr. Telesforo Tioaquen, B.S.A. '33 (graduated June, 1932) is working with Mr. Carlos Sandico, an extension alumnus, Poultry Class of 1931, in developing Mr. Sandico's poultry farm in Mexico, Pampanga. At present, the farm has a little over 600 layers, mostly Los Baños Cantonese, but indications now show that by next September they will have at least 3,000 layers.

Mr. Severino L. Salvado, '31 was a recent Campus visitor. He is connected with the Bureau of Prisons, and was recently appointed in charge of poultry at San Ramon Penal Colony, Zamboanga.

Mr. Valentin Amon, '30 is in charge of the Bureau of Prisons Poultry Farm located at Correctional Institution for Women, San Felipe Neri, Rizal.

Mr. Melecio M. Manio, B.Agr. '19, writes to Doctor Fronda informing him that he is temporarily assigned in the General Kitchen of Bilibid Prisons to relieve Mr. Daniel F. Asuncion, B.S.A. '31, who will soon be sent to Davao Penal Colony. Mr. Manio was formerly assigned in the Colony as its agriculturist.

Mr. Petronilo Carambas, '32 was on the Campus on November 8. He consulted Doctor Fronda regarding some positions on poultry farms that have been offered to him.

A number of additional poultry houses are in the process of construction in the Poultry Division. These are necessary to accommodate the rapidly increasing needs of the poultry work of the College.

ERRATA

In November issue of THE PHILIPPINE AGRICULTURIST on page 413, last page of table 10 the third column should read:

EQUIVALENT AMOUNT OF FUEL USED IN TERMS OF THE MOST ECONOMICAL KEROSENE			
Full load		Half load	
by wt.	by vol.	by wt.	by vol.

ELECTRICITY, THE MODERN HANDMAID OF CHEMISTRY

Science Service Radio Talks

The science and art of chemistry had its beginnings many thousand years ago. Thus, such chemical products as soap, glass, paper and porcelain were known to the ancients, and the knowledge of manufacturing these and other products was handed down from generation to generation. Who was the inventor of soap—one of the most important of chemical products? His name and origin have long since been forgotten. Through the ages up to as recently as 1800, there were but slight changes in the process of manufacture of soap and many other chemical products. New and valuable articles were added from time to time, but the basic method of preparation and manufacture remained inherently the same. With the close of the eighteenth century, however, the classical discoveries of Galvani and of Volta opened to the chemist an entirely new field of attack. Chemical products could be made or decomposed by electricity. The epoch-making discoveries of Galvani and Volta in Italy stimulated research throughout Europe, and within a few years Michael Faraday, of England, announced to the world his discoveries of the intimate interrelation between electrical and chemical phenomena. By the middle of the nineteenth century the comparatively limited supply of electricity from the Volta battery was infinitely increased through the invention and perfection of the electric dynamo—a machine that converted readily available, mechanical power into electrical energy.

After the appearance of the electric dynamo, the greatest forward step in chemistry and chemical manufacture took place: not only were old processes—cumbersome and costly—discarded, and new, electrical clean and simple processes substituted therefore, but a host of new products were discovered. New metals, such as sodium, magnesium and aluminum, never before known to man, were extracted with the aid of electricity from familiar salts. Chlorine gas which is the underlying basis of our bleaching industry, was formerly made by a very lengthy and wasteful chemical process. Now, by merely pass-

ing an electric current through water in which ordinary table salt is dissolved, tons of this yellowish-green gas are produced, and so easily and cheaply that the industry is forever turning out more chlorine than is consumed by the public. And this very electrical, or electro-chemical process, which produces chlorine gas at one pole, produces caustic or lye at the other pole, simultaneously. This caustic or lye is mixed with animal fats and made into soap.

In 1892, Thomas Willson, an American, mixed ordinary marble with coal and passed a strong electric current through the mixture. He obtained a new "stone" or compound, calcium carbide. Returning from lunch on the day of his discovery, it started to rain, and the rain-drops coming in contact with his new product caused a hissing sound and a powerful gas—acetylene—was evolved. This day marked the birth of one of the foremost of chemical industries—calcium carbide, acetylene, hydrocyanic gas, acetone, acetic acid, solvents, etc.

In 1891, Edward Goodrich Acheson, one of our foremost pioneers in electro-chemistry, passed electricity through coal and converted it into graphite—a most valuable lubricant—better and purer than any natural graphite theretofore produced. No lubricant other than Acheson graphite will stand the temperatures developed in our modern super-high-speed bearings. In another experiment Dr. Acheson powdered ordinary coal and mixed it with Coney Island sand, adding a little salt as seasoning. He then sent a powerful current of electricity through this mixture—so powerful that the sand was changed into gas—and the result of the experiment was a new product—carborundum—which you use to sharpen your carving knife or razor blade.

Many of the chemical plants at this time were expanding, and new ones were being erected in different parts of the country. From the smoke-stacks of these factories thick fumes and often acids belched forth which ruined trees and other vegetation, not to mention the discomforts brought upon people working or living in the vicinity of these factories. F. G. Cottrell suspended a chain through the center of these smoke-stacks, applied a high voltage current and lo, and behold, no fume, no dust any longer came out of the stacks, just as though the factories had shut down completely. But, of course, they had not. Electricity was causing those myriads of smoke and fume particles of go down instead of up. And more than this: the dust was collected and in many cases was found to contain valuable constituents, such as silver. This Cottrell process is so simple that many

factories, such as fertilizer factories, instead of avoiding smoke, find it to their advantage to first convert their products into fume or smoke and then pass electricity through the smoke and throw down or precipitate the fine particles subsequently converted into high-grade baking powder and other products.

The ancients knew how to apply gold coatings to baser metals, such as bronze and copper, but the process was tedious and uncertain. The gold had to be first hammered or beaten out into very thin sheets, a process that often took several days to complete. The sheet or gold leaf obtained usually had many holes and other imperfections. This leaf was then mechanically fastened to the surface of the bronze or copper and the bond or union was never very secure, so that the slightest knock or scratch would loosen the leaf. To-day the articles, such as jewelry made of base metals, is suspended into water containing a little gold dissolved in it. Electricity is passed through the water, and almost instantly the brooch or ring or other article is completely covered with a resplendent coat of our most noble metal, gold. The coating is uniform and thoroughly adherent. And gold is not the only metal that is now plated over other metals by electricity. Silver, nickel, zinc, lead, copper, tin and chromium are similarly plated to-day. Without electricity your car would have no chromium plate.

Iron is one of the oldest and most serviceable of metals. Yet nearly everything that was ever made of iron by our forefathers has long since turned to rust and disappeared. Only a few rare specimens have been preserved and handed down to us. It is this tendency for iron and steel to rust that has for years stimulated investigations in all civilized countries of the world, with the hope of making iron and steel rust proof. Here, again, electricity has been the immediate means toward a solution of the problem. By mixing iron with other metals, notably chromium, and passing powerful electric currents through these mixtures, iron alloys have been produced, such as stainless steel and the chromium-nickel alloy that covers the Chrysler Building, which defy rust and deterioration for all time to come.

Many more examples fully as startling as those cited could be recorded and suggestions might be offered as to electrochemical discoveries and inventions of the future. To mention but a few, we need new products and processes to convert our super-heavy railway equipment into such that will excel that of the modern airplane. We need a chemical machine that will convert the boundless energy of

the sun—most of which is wasted to-day—directly into electricity, instead of first converting a mere fraction of sun energy into trees and trees into coal, and coal into heat and heat into steam and steam into electricity. We want to apply electricity to different substances and change these substances easily and rapidly into a food as valuable as milk and as cheap and abundant as spring-water. We want to produce by electrical and chemical means materials harder than diamond and much cheaper than gems, to produce metals lighter than aluminum and stronger than steel, electric lamps ten times as efficient as the best tungsten lamp of to-day, to produce dyes that never fade, and silver that does not tarnish. The investigator in chemistry to-day is indeed fortunate to be able to apply electrical methods in seeking a solution of these and many other important problems.—COLIN G. FINK, *Head, Division of Electrochemistry, Columbia University.*

Reprinted from *The Scientific Monthly* November, 1932

Possibly the simplest and most practical statement of ideals I have ever heard is that of Sir William Osler, the great surgeon, who said, "I have had three personal ideals. One to do the days' work well and not to bother about tomorrow . . . The second ideal has been to act the Golden Rule as far as in me lay . . . And the third has been to cultivate such a measure of equanimity as would enable me to bear success with humility.

Penn State Farmer, October, 1932

"When you're all tired out and ready to drop,
And men's ways seem mean and vile,
Don't frown and scowl and glare at the world—
Surprise them all with a smile.
'Twill take less out of your tired old hulk,
'Twill tide you over awhile;
For it takes sixty-four muscles to fashion a frown
And only thirteen for a smile."

STUDIES ON GERMINATION, DEGREE OF TILLERING AND
VIGOR OF PLANTS OF TOP AND CUT-BACK SEED-
PIECES OF P. O. J. 2878 SUGAR CANE
(SACCHARUM OFFICINARUM)¹

VALERIANO C. CALMA
Of the Department of Agronomy

WITH EIGHT TEXT FIGURES

The losses produced by using the wrong seed-piece of sugar cane has been a subject of interest to many investigators, but as yet no effort has been made in the Philippines to study the comparative merits of top and cut-back seed-pieces.² It is a common practice among farmers when growing sugar cane on a commercial scale to plant only the top seed-piece and not the cut-back. This practice prevails especially in the tropics where for centuries the cane has been propagated from extreme tops. Contrary to this practice of planting canes, in Louisiana the entire stalk has been used for "seed" ever since the introduction of the industry, according to Stabbs (1915). In Java, cut-back seed-pieces were utilized with the view of escaping the cane disease, sereh; for some unknown reason seed-pieces grown at high elevations of two to three thousand feet above sea level when planted in the lowlands usually escape sereh. Until recently, cut-back seed-pieces were not used in the Philippines. But with the introduction of P. O. J. 2878, a high yielding variety of sugar cane, it was desired to propagate it rapidly, so cut-back seed-pieces are now being used. Other promising varieties are also being propagated with cut-back seed-pieces from specialized propagating fields.

¹ Experiment Station contribution No. 856. Read before the Los Baños Biological Club August 25, 1932. Received for publication October 1, 1932.

² A *top seed-piece* is the cutting obtained from the youngest portion of the cane.

Ordinarily, *cut-back seed-pieces* refer to the seed-pieces obtained from parent fields or "semilleros" where the cane was grown expressly for the purpose of being used for seed-pieces. In the present study cut-back seed-pieces means any portion of the cane used for "seed" after the top seed-piece has been removed.

The sugar cane crop planted during January, February and March, 1932 in the sugar cane field of the College of Agriculture was closely observed. With Pampanga Red and Luzon White, native varieties, top seed-pieces were used, with P. O. J. 2878, cut-back seed-pieces. The native varieties showed a uniform superiority in germination over the P. O. J. 2878. This outstanding difference attracted the writer's attention and the question was raised: Is this significant difference due to the seed-pieces used? The extraordinarily poor stand (see fig. 1) of P. O. J. 2878 cane led the writer to investigate the cause or causes of the poor germination.



Fig. 1.—A field planted with cut-back seed-pieces of P. O. J. 2878 sugar cane, showing the poor stand resulting from the attack of termites and pineapple disease caused by *Thielaviopsis paradoxa* (de Seynes Höh.). Note the many missing hills at the extreme left due partly to the infestation of termites in green manured plots. In the foreground is the control plot which shows many missing hills, a result of pineapple disease. The photograph was taken 86 days after planting. (All photographs by Photographic Division, Department of Soils.)

In the final analysis sugar cane growers are more directly concerned about the sugar yields per hectare than in the comparative germination of cane varieties. If a variety yields well in spite of poor germination, attention should be directed towards methods of improving germination, such as the use of the proper kind of seed-piece, the use of fresh seed-pieces, the use of large seed-pieces, soaking seed-pieces in different media, etc.

In Louisiana, Stabbs (1915) reports that continuous yearly plantings have been made using "tops from tops", "middles from middles" and "butts from butts" of two varieties of sugar cane. After thirteen years of experimentation it was found that the average yields of the two varieties of cane, Louisiana Purple and Louisiana Striped, from each "tops", "middles", and "butts" were so nearly identical as to dispel any pronounced prejudice or preference for any portion of the stalk as seed. Lee and Quizon (1929) studied in the Philippines the relation of size of seed-piece to germination using a variety which they claimed to be Hawaiian Uba cane. The germination of two-eye seed-pieces was compared with the germination from three-eye seed-pieces and ten-eye seed-pieces. These authors found that the percentage of germination of the whole seed-piece was highest in the case of ten-eye seed-pieces; which gave 90 per cent; the next best was the three-eye seed-pieces, with 56 per cent; and the poorest was the two-eye seed-pieces, with 32 per cent.

OBJECTS OF THE PRESENT WORK

The investigation here reported had for its objects the following: (a) To determine the comparative germination of top and cut-back seed-pieces; (b) to determine the effects on germination of soaking seed-pieces for various lengths of time in different media; (c) to determine the effects of varying amounts of moisture in the soil on germination and vigor of plants grown from the different sections of the cane; (d) to determine the comparative degree of tillering and vigor of plants of top and cut-back seed-pieces; and (e) to determine the comparative degree of tillering and vigor of plants of the different sections of the cane.

TIME AND PLACE OF THE PRESENT WORK

The investigation was conducted from March 5, to August 3, 1932 covering a period of about five months. The experiments were performed under laboratory conditions in the Farm Crops Division of the Agronomy Department, and under field conditions in the experimental field of the College of Agriculture.

MATERIALS AND METHODS

Materials

Planting materials. Sugar cane seed-pieces of the variety P. O. J. 2878 were used in this study. The planting materials were ob-

tained from two sources. The first batch of seed-pieces was obtained from the Pampanga Sugar Mills, Del Carmen, Pampanga and was used in experiments 1, 2, and 4. The second batch of seed-pieces was obtained from the sugar cane field of the College of Agriculture and was used in experiments 3 and 5. All the seed-pieces were obtained from canes five to six months old.

Soaking media. Lime-magnesium sulfate solution and water were used for soaking the seed-pieces.

Germinating media. Petroleum boxes and cans containing clay loam soil were used for germinating the seed-pieces. Germination studies were made also in the sugar cane field of the College of Agriculture.

Methods or procedure

Experiment 1: the effects on germination under laboratory conditions of soaking top and cut-back seed-pieces for varying lengths of time in different media. Petroleum boxes were each divided into halves and petroleum cans opened at one end and drainage holes made in the other end. The cans were then filled about two-thirds full of sieved clay-loam soil.

As ordinarily used in commercial plantings, the seed-pieces were cut the same length, about 25 to 30 cm. When received, most of the seed-pieces from the Pampanga Sugar Mills were infected with pineapple disease caused by *Thielaviopsis paradoxa* (de Seynes Höh.) ; unquestionably, some were infected when cut and the disease, because of favorable conditions during transit for its development, spread.³ Before any treatment was given, portions of the ends of the seed-pieces close to the nodes were cut off to minimize pineapple disease infection. The top seed-pieces were separated from the cut-back seed-pieces. Each of the top seed-pieces had three to six nodes or eyes and each of the cut-back seed-pieces had only two to three nodes or eyes. In spite of the fact that the seed-pieces were of the same length, there was a great difference in the number of nodes or eyes on the top and the cut-back seed-pieces because the latter had longer internodes than the former.

³ In shipping, the seed-pieces were in a warm and humid freight car for about two days, an ideal condition for the spread of fungus spores and subsequent infection.

The lime-magnesium sulfate solution was prepared according to the following formula:

Volume of the solution	200	gallons
Amount of lime	14	kilograms
Amount of magnesium sulfate ..	1.81	kilograms

The lime was slaked in a barrel. The magnesium sulfate was dissolved in water and thoroughly mixed with the lime in the barrel. The mixture was made to the required volume by the addition of tap water. Some of the seed-pieces were soaked in the media for 12 hours, some, 24 hours, some, 36 hours, and some, 48 hours. Immediately after the soaking, the seed-pieces were planted flat in the germinating media and covered to a depth of about eight cm..

The cultures were watered when it was deemed necessary. They were examined daily to record initial germination. On April 11, 35 days after planting, the seed-pieces were dug up to record the final germination. At the end of the experiment, representative cultures were photographed.

In reading the germination tests it seemed best to consider a seed-piece as having germinated only when it possessed both roots and shoot, for it did not seem justifiable to consider as germination the appearance of roots or a shoot alone. Accordingly, in the present study, the time of germination was taken as the period required for the point to produce a normal shoot and roots. Oftentimes a cane point will produce roots but not shoot, and *vice versa*. Under this condition growth soon ceases and germination is not considered as having taken place. Initial germination, as used in this paper, refers to the period when the shoots appeared above the soil. Complete germination signifies the stage reached when there was no further increase in the number of seed-pieces germinating.

Experiment 2: the effects on germination under field conditions of soaking top and cut-back seed-pieces for varying periods in different media. In order to test the validity of the results obtained in experiment 1, and in order to test a greater number of seed-pieces this experiment was conducted. A small area of land in the sugar cane field of the College of Agriculture was used for this study. The moisture content of the soil was determined following the usual method. The furrows were made 75 cm. apart. Two cuttings were planted in a hill, setting them 30 to 40 cm. apart end to end in the row.

They were planted flat and, because of the dry condition of the soil, were covered to a depth of 10 to 15 cm. On May 13, 1932, 66 days after planting, the percentage of germination was recorded.

Experiment 3: the effects of varying amounts of moisture in the soil on germination and vigor of plants grown from the different sections of the cane. This experiment was conducted to determine the optimum moisture for germination of P. O. J. 2878 seed-pieces and to gain information as to the comparative germination between the top and a more definite section of the cane. Petroleum cans were each divided into halves. The bottom of each can was sealed to prevent the escape of water or moisture. The soil was sieved and then exposed in the laboratory so as to make it air-dry. The percentage of moisture was determined as before. From the air-dried soil, soil having varying amounts of moisture content as 10 per cent, 15 per cent, 20 per cent, and 25 per cent, were prepared. The moisture content of the soil was adjusted by adding the amount of water calculated to make the desired concentration and mixing thoroughly.

The seed-pieces were prepared by dividing the entire cane into three equal portions, the butt, middle, and the top. Each of these portions was in turn divided into two equal seed-pieces. Only the top-most portion of the cane was used as top seed-piece. The butt and middle seed-pieces had longer internodes than the top ones, resulting in a greater number of nodes or eyes in the top than in either of the other two kinds of seed-pieces. The top seed-pieces had each three to six nodes or eyes and the butt and middle ones had each two to three nodes or eyes.

The cuttings were soaked for 36 hours in running water. They were then planted in cans containing soil with varying amounts of moisture. The cuttings were laid flat on the soil and covered to a depth of about eight cm. Two cuttings were planted in each can. There were 10 replications in each treatment. The weight of the can including its contents was adjusted to exactly eight kgm. by either adding or removing some soil. Each can had from 6,112 to 8,640 cc. of soil. The cultures were placed in a partially shaded portion of the laboratory to prevent rapid evaporation. The loss in weight, determined on a Fairbanks balance, which represented the amount of water evaporated, was restored every other day by adding water.

The cultures were examined every other day to record the germination and vigor of the plants. On May 29, 43 days after planting,

the seed-pieces were dug up to record final germination, number of shoots and relative vigor of the plants. The roots of the plants were washed thoroughly in running water and the plants with their root systems from the various treatments were photographed.

Experiment 4: a study of the comparative degree of tillering and vigor of plants grown from top and cut-back seed-pieces. In this experiment, larger propagating pots or containers were used so as to determine the comparative degree of tillering and vigor between plants of top and cut-back seed-pieces. One hundred and twenty petroleum cans with drainage holes in the bottom were made ready. A clay-loam soil was first pulverized, sieved, and thoroughly mixed and then placed in the cans. Each of the cans had a surface area of 576 sq. cm. and contained 19,584 cc. of soil.

About 500 top and cut-back seed-pieces were first germinated in a wardian case containing sawdust which was kept moist to hasten the sprouting of the buds. When the shoots were about 15 cm. tall, young plants of apparently uniform vigor and state of development were selected. Two sets of pot cultures were started from these plants. A set of 60 plants of top seed-pieces, and another set of 60 plants of cut-back seed-pieces were planted one plant to a pot. The cultures were placed outside of the laboratory; the plants of top seed-pieces were set in rows alternately with those of cut-back seed-pieces. The first 42 plants from each set of cultures or treatment were set 75 cm. by 75 cm. apart and were placed in a partly shaded place. The remaining 24 plants from each of the two sets were set 125 cm. apart alternately in a single row and were fully exposed to the sun.

The plants were watered and cultivated when it was deemed necessary. The behavior of the plants of the two sets of cultures was closely observed and any unusual changes in their appearance were recorded.

On July 22, 1932, the number of stalks or tillers were counted. Final counts of the number of stalks were made on August 3, 1932, about five months after planting. The height and diameter of the tallest stalk in each pot or stool were recorded. The tallest stalk was measured from the base mark to the ligule of the youngest visible leaf sheath. The diameter was measured with a caliper at a point about five cm. from the base. Representative cultures were selected and photographed.

Experiment 5: a study of the comparison of tillering and vigor of plants grown from different sections of the cane. In order to verify the results obtained in experiment 4, experiment 5 was conducted. In this experiment, larger pots or containers were used to give more space for the spread of the roots. Thirty petroleum boxes with drainage holes in the bottom were used. Each box had a space area of 1,998 sq. cm. and contained 53,896 cc. of soil. The clay-loam soil was pulverized, sieved and then thoroughly mixed.

In this experiment the different sections of the cane were used to gain information as to their merits as compared with top seed-pieces. The whole cane was divided into three equal portions, the butt, middle, and the top. Each of these was in turn divided into two equal seed-pieces. Only the topmost portion of the cane was used as top seed-piece. About 500 seed-pieces were first germinated in a wardian case as in experiment 4. From these, young plants of apparently uniform size and vigor were selected. Three sets of pot cultures of plants of butt, middle, and top were started from these plants. Each germinated seed-piece was planted in a box. There were nine replications in each treatment. The plants were placed outside of the laboratory where they received the full benefit of the sun.

The plants were watered and cultivated when necessary. The behavior of the plants in the different cultures was observed and any unusual changes in their appearance were recorded.

On July 22, 1932, the number of stalks or tillers from each stool was counted. Final counts of the number of stalks were made on August 3, 1932. The height and diameter of the tallest stalk were obtained. The tallest stalk was measured from the base mark to the ligule of the youngest visible leaf sheath. The diameter was measured with a caliper at a point about five cm. from the base. Representative cultures were selected and photographed.

RESULTS AND DISCUSSION

Experiment 1: the effects on germination under laboratory conditions of soaking top and cut-back seed-pieces for varying lengths of time in different media. The results of this experiment are presented in tables 1 and 2 and figures 2, 3, 4a, and 4b. Table 1 shows the comparative germination under laboratory conditions between top and

cut-back seed-pieces of sugar cane soaked for varying lengths of time in different media. The data show that the germination of top seed-pieces was consistently better than of cut-back seed-pieces. In all the treatments there was a higher percentage of germination of top seed-pieces than of cut-back. Top seed-pieces soaked in water for 48 hours gave 55 per cent more germination than the cut-back seed-pieces which were given same treatment; this was the highest increase recorded. This same treatment gave the lowest germination for cut-back seed-pieces, 35 per cent, and fairly good germination, 90 per cent, for top seed-pieces.

With the treatment, soaking for 48 hours in lime-magnesium sulfate solution, the germination of top seed-pieces was only 5 per



Fig. 2.—Showing the comparative germination between top and cut-back seed-pieces of P. O. J. 2878 under laboratory conditions. Cultures at the left are those of top seed-pieces and at the right of cut-back seed-pieces. Note the higher percentage of germination and production of greater number of shoots of top seed-pieces than of cut-back seed-pieces. The photograph was taken 30 days after planting.

cent more than that of the cut-back. It will be noted that this treatment gave 80 per cent germination, the highest for cut-back seed-pieces, and 85 per cent germination for top seed-pieces.

It is interesting to note that the highest percentage increase of germination of top over cut-back seed-pieces was recorded from seed-pieces soaked for 48 hours in water, and the lowest was obtained from those soaked for the same length of time in lime-magnesium sulfate solution. A possible explanation of this significant result is that the lime-magnesium sulfate solution might have inhibited the development of the pineapple disease. Water may have favored the development of this disease, at least in the cut-back seed-pieces; most of the seed-pieces that did not germinate were badly infected with pineapple disease (see fig. 3.). The average percentage of germination of the

various treatments was 85 for top and 53.88 for cut-back seed-pieces. The results thus far obtained indicated that top seed-pieces gave a higher percentage of germination than cut-back seed-pieces. This is shown graphically in figure 4a.

Table 2 shows the effects on germination under laboratory con-



Fig. 3.—Showing two cut-back seed-pieces of P. O. J. 2878 sugar cane dug up after being several weeks in the ground, and found to have been killed by pineapple disease, *Thielaviopsis paradoxa* (de Seynes Höh.). From left to right, 1, ordinary cut-back seed-piece, and 2, cut-back seed-piece split open. Note that “pipe” has formed in the interior of the seed-piece and that the sooty-black spores of the fungus impart a dark color to the “pipe.” Also note that the eyes of both cuttings have died as a result of the disease.

ditions of soaking seed-pieces of sugar cane for varying lengths of time in different media. It may be seen in this table that all the seed-pieces soaked in lime-magnesium sulfate solution gave a percentage of germination higher than the control, and that the increase in percentage of germination of the treated seed-pieces over the control was in direct association with the length of soaking in the medium. May (1927) in his studies on seed treatments of sugar cane found that lime-magnesium sulfate solution had apparent good effects after one day's soaking; two days was sufficient to give ultimate benefit and in no case was found detrimental. Eight days soaking was found to be detrimental. It may be noted in table 2 that water gave inconsistent results. Seed-pieces soaked in water for 24 hours and 48 hours gave the same percentage of germination as the control, and those soaked for 12 hours and 36 hours gave an increase of germination over the control of 10 per cent and 7.5 per cent, respectively.

It may be seen also in table 2 that lime-magnesium sulfate solution was a better soaking medium than water. With but one exception, that is, those soaked for 12 hours, seed-pieces soaked in lime-magnesium sulfate solution for varying lengths of time gave a higher percentage of germination than those soaked in water. This excep-

tion may be explained by the fact that the apparent beneficial effect of lime-magnesium sulfate solution was not manifested for the first 12 hours. This result corroborates the findings of May (1927) who reported that lime-magnesium sulfate solution had apparent good effects after one day, and two days was sufficient to give the ultimate benefit. Seed-pieces soaked for 48 hours in lime-magnesium sulfate solution gave the highest percentage of germination, with 82.5, 20 per cent better than the control.

On the whole, the data presented in table 2 indicate that lime-magnesium sulfate solution was a better soaking medium than water. Its beneficial effect was more apparent on cut-back than on top seed-pieces; this beneficial effect was in direct association with the length of soaking in the medium, that is, up to 48 hours the beneficial effect became more apparent as the length of time was increased. Water was detrimental to cut-back seed-pieces after 48 hours.

Experiment 2: the effects on germination under field conditions of soaking top and cut-back seed-pieces of sugar cane in different media. The results of this experiment are recorded in tables 3 and 4, and shown graphically in figure 4c. Table 3 shows the comparative germination under field conditions of top and cut-back seed-pieces of sugar cane soaked in different media. It may be noted in table 3, that with the exception of those soaked for 48 hours in stagnant water, top seed-pieces gave a higher percentage of germination than cut-back seed-pieces. Top seed-pieces soaked in lime-magnesium sulfate solution gave the highest percentage of germination, 30.93 per cent, 16.11 per cent higher than the cut-back seed-pieces. Top seed-pieces soaked in running water ranked next highest in percentage of germination, with 24.19 per cent, 9.37 per cent higher than the cut-back seed-pieces. Unsoaked top seed-pieces were 6.2 per cent higher in germination than cut-back seed-pieces. Top seed-pieces soaked for 48 hours in stagnant water were 6.16 per cent lower in germination than the cut-back seed-pieces. This extremely low germination recorded for top seed-pieces may be accounted for in part by the favorable development of the pineapple disease in stagnant water. As a rule, the deterioration of seed-pieces is largely due to infection through the cut ends of the seed-pieces by microorganisms such as *Thielaviopsis paradoxa* (de Seynes Höh.). Such organisms are more abundant in muddy, dirty stagnant water than in clear running water. Typical seed-pieces of sugar cane which failed to germinate owing

partly or wholly to pineapple disease infection are shown in figure 2. The results obtained under field conditions verified those recorded under laboratory conditions, which were that top seed-pieces gave better germination than cut-back seed-pieces. These results are shown in graphical form in figures 4b and 4c. This uniform supe-

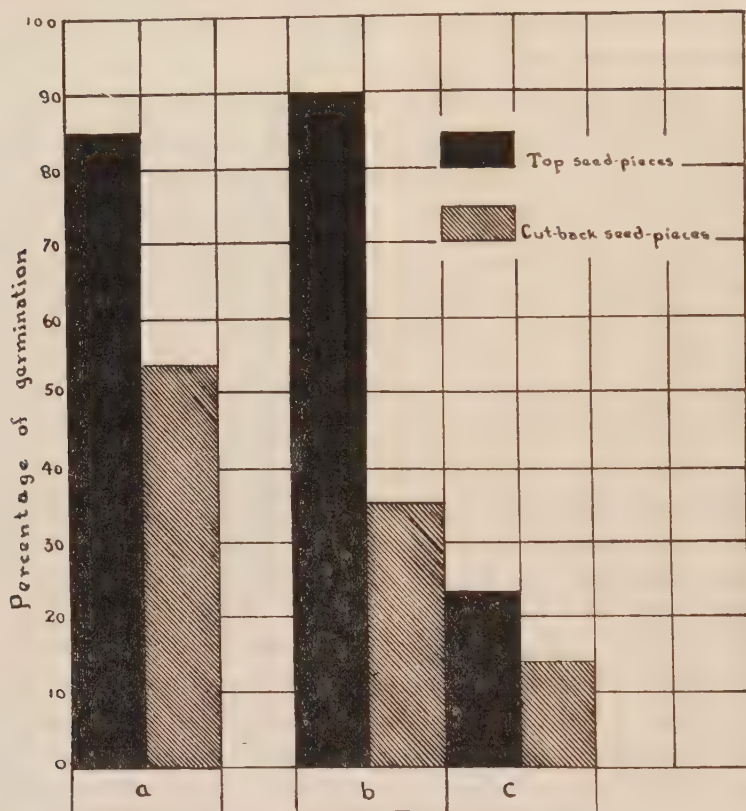


Fig. 4.—Showing percentage of germination; (a) average percentage of germination under laboratory conditions of the various treatments; (b) percentage of germination under laboratory conditions of top and cut-back seed-pieces soaked for 48 hours in running water; and (c) percentage of germination under field conditions of top and cut-back seed-pieces soaked for 48 hours in running water.

riority of germination of top over cut-back seed-pieces is worthy of note, and it may be concluded from the foregoing results that germination of cut-back seed-pieces handled as in these experiments is not as good as that of top seed-pieces. Attention by planters to this fact might increase the yields per hectare.

Table 4 shows the effects on germination under field conditions of soaking seed-pieces of sugar cane in different media. It may be seen in table 4 that with the exception of seed-pieces soaked for 48 hours in stagnant water, which gave a germination 12.36 per cent lower than that of the control, soaking the seed-pieces increased the percentage of germination. As has been stated, this very low germination of top seed-pieces soaked in stagnant water may be accounted for in part by the favorable condition for the development and spread of the pineapple disease. Lime-magnesium sulfate solution gave the best results. Seed-pieces soaked for 48 hours in this solution gave a germination of 30.93 per cent, which was 9.91 per cent higher than the control. An increase of 3.17 per cent in germination was obtained by soaking seed-pieces for 48 hours in running water. The results obtained under field conditions confirmed those obtained under laboratory conditions, that lime-magnesium sulfate solution was a better soaking medium than water. These results agree with the findings of May (1927) who reported that lime-magnesium solution gave better results than either lime-water or water alone. Roxas and Grecia (1929) also reported that lime-magnesium sulfate solution increased the yield of cane and sugar. The treatment of seed-pieces with lime-magnesium sulfate solution can be given on a large scale and can be economically followed by farmers. The cost of soaking 32,000 seed-pieces, or the per hectare cost of the solution is only ₱2.73, calculated as follows:

Volume of solution to soak 32,000 seed-pieces	200 gallons
Amount of lime, 14 kgm. @ ₱0.30 a kgm.	₱4.20
Amount of magnesium sulfate, 1.81 kgm. @ ₱0.64 a kgm.	1.16
Cost of labor in preparing the solution	0.10
<hr/>	
Total	₱5.46

About 50 per cent of this solution will be left after soaking the first batch of seeds and the other 50 per cent may be absorbed by the seeds or be mechanically lost. The solution that is left may be used again by replacing only the amount used or lost. Undoubtedly, the value of increase in yield from a good stand of cane resulting from the treatment will over-balance the cost of the treatment.

It may be seen in tables 1-4 and figures 4b and 4c that the percentage of germination of both top and cut-back seed-pieces was much higher under laboratory than under field conditions. Under laboratory conditions, top seed-pieces soaked for 48 hours in running

water gave 90 per cent germination; under field conditions the percentage of germination was only 24.19. Under laboratory conditions, cut-back seed-pieces soaked in running water for 48 hours gave 35 per cent germination; under field conditions a germination of only 14.82 per cent was obtained. These significant differences may be explained by the difference in moisture conditions, that is, there was adequate moisture for germination in the laboratory but in the field the soil was so dry as to be below the optimum for germination. Analyses of soil obtained from the field at the time of the experiment (March 7, 1932) gave only 16.37 per cent moisture. These results indicate very clearly the importance of moisture as a factor for germination of P. O. J. 2878 seed-pieces, and hence the inadvisability of planting this variety of sugar cane during the dry months of January to April. Although these results were obtained with the P.O.J. 2878 variety the general principle may apply to other varieties.

Tables 1-4 show that the beneficial effects on germination of soaking seed-pieces of sugar cane were more evident under field conditions than under laboratory conditions. This is substantiated by the fact that under laboratory conditions seed-pieces soaked for 24 hours and 48 hours in running water gave the same percentage of germination as the unsoaked or control. Under field conditions, however, all seed-pieces soaked in running water gave a higher percentage of germination than the unsoaked or control; nevertheless, those soaked for 48 hours in stagnant water gave poorer germination than the control. The reason for this is obvious, because of the adequate moisture for germination under laboratory conditions the beneficial effect from further soaking in water was not required.

These results suggest that soaking seeds to insure higher percentage of germination should be resorted to during the dry months of January, February, March and April. In September, October, and November when there is sufficient moisture in the soil to supply that required for germination, soaking is unnecessary as the bud can obtain moisture necessary for germination and subsequent growth from the soil.

Experiment 3: the effects of varying amounts of moisture in the soil on germination and vigor of plants of the different sections of the cane. The results of this experiment are shown in table 5 and figure 5. Table 5 shows the effects of varying amounts of moisture in the soil on germination and vigor of plants of different sections of the cane. It may be observed in table 5 that none of the seed-pieces

germinated in soil containing 10 per cent moisture. The seed-pieces were dry and hollow and produced neither root nor shoot. None of the ungerminated seed-pieces were infected with pineapple disease. In soil containing 15 per cent moisture none of the butt and middle seed-pieces germinated; the top seed-pieces gave 70 per cent germination. These results agree with the findings of Lee and Quizon (1929) who reported that the percentage of germination of the whole seed-piece was highest in the case of the ten-eye seed-piece; the next best was the three-eye seed-piece; and the poorest was the two-eye seed-piece.

Some of the butt and middle seed-pieces showed root but not shoot formation and *vice versa*. It was also observed that the leaves of

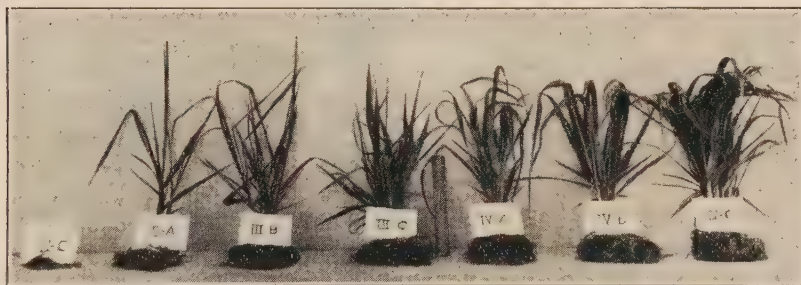


Fig. 5.—Showing the relative growth and development in soil containing varying amounts of moisture of sugar cane plants from the different sections of the cane at the age of 41 days. From left to right: culture II-C, top in 15 per cent moisture; culture III-A, butt in 20 per cent moisture; culture III-B, middle in 20 per cent moisture; culture III-C, top in 20 per cent moisture; culture IV-A, butt in 25 per cent moisture; culture IV-B, middle in 25 per cent moisture; and culture IV-C, top in 25 per cent moisture.

the plants of the top seed-pieces wilted showing insufficient amount of moisture for the normal growth of the plants. In soil containing 20 per cent moisture, all the seed-pieces of the different sections of the cane showed fairly good germination. There was a descending order in the percentage of germination from the top to the butt seed-pieces; the top, 100, the middle, 80, and the butt, 60. A still higher percentage of germination of the seed-pieces was obtained in soil containing 25 per cent moisture. With the exception of the middle seed-pieces which gave only 80 per cent germination all the other sections of the cane gave 100 per cent germination. These results indicate that 20 per cent moisture was approaching the optimum and that 25 per cent was about the optimum moisture for germination of

seed-pieces of P.O.J. 2878 sugar cane. It is worthy of note that in this third experiment the butt and middle seed-pieces which really corresponded to the cut-back seed-pieces gave percentages of germination higher than the cut-back seed-pieces used in the first and second experiments. In this experiment as much as 100 per cent germination of butt seed-pieces was obtained in soil containing 25 per cent moisture. This outstanding difference may be accounted for in part by the fact that some of the seed-pieces used in the previous experiments were infected with pineapple disease whereas those used in this third experiment were fresh and free from this malady, having been soaked in water and planted immediately after they were cut in the field.

It also may be seen in table 5 that there was a descending order in the number of shoots produced from top to butt seed-pieces. As the top seed-pieces had more nodes than either the middle or butt seed-pieces, obviously they would produce more shoots than either of the other two. In all cases the top seed-pieces germinated earlier than either the middle or butt seed-pieces.

The greater the moisture content of the soil the earlier the seed-pieces germinated, and the greater were the number of shoots produced. It was observed also that the plants in soil containing 20 per cent and 25 per cent moisture had normal green leaves and were more vigorous than the drying plants in soil containing 15 per cent moisture. This is clearly seen in figure 5. These results suggest that 20 per cent moisture was approaching the optimum for seed-piece germination and normal growth of plants of P.O.J. 2878. The results of this experiment verified those obtained from the field in which a poor stand was obtained because of an inadequate moisture in the soil. From these results it may be concluded that under planting conditions with soil moisture below the optimum (20 to 25 per cent), top seed-pieces are desirable; while with seed-pieces taken from any other portion of the cane, poorer germination may be expected. If cut-back seed-pieces are used, it might be well to increase the number of seed-pieces planted per hectare.

Experiment 4: a study of the comparative degree of tillering and vigor of plants of top and cut-back seed-pieces. Tables 6 and 7 and figure 6a show the results of this experiment.

Table 6 presents the comparative degree of tillering between plants of top and cut-back seed-pieces of sugar cane. It may be seen in this table that plants of the top seed-pieces produced more tillers

than those of the cut-back seed-pieces. The plants of the top seed-pieces had an average of tillers of 8.10 ± 0.2878 ; the cut-back, 6.70 ± 0.1630 . For every 100 tillers produced by the plants of the cut-back seed-pieces, 120 tillers were produced by those of the top seed-pieces, a difference of 20 tillers in favor of the top seed-pieces. The difference in the degree of tillering between top and cut-back seed-pieces

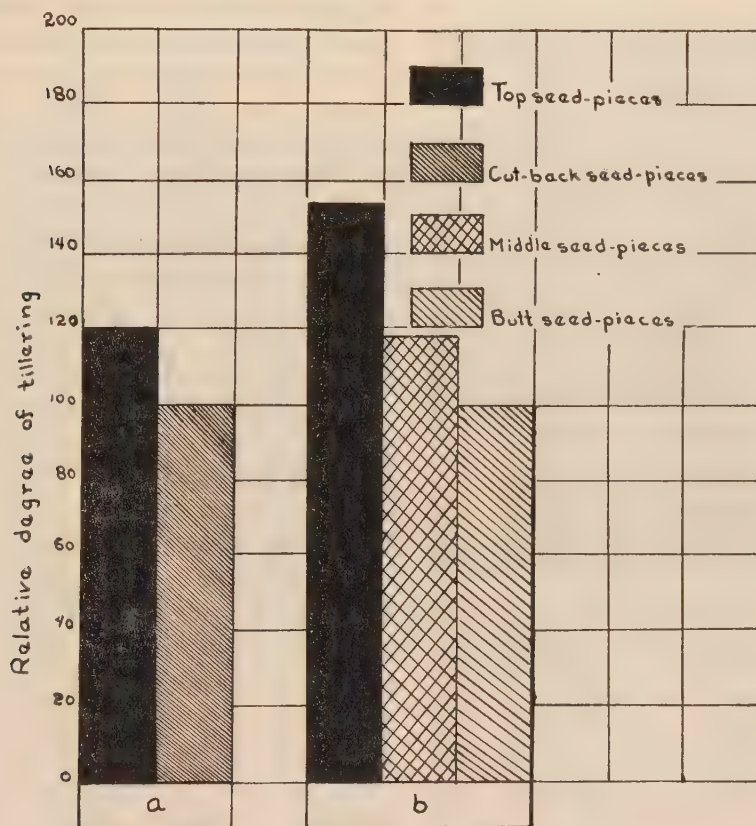


Fig. 6.—Showing relative degree of tillering; *a*, relative degree of tillering between plants of top and cut-back seed-pieces, and *b*, relative degree of tillering between plants of top, middle, and cut-back seed-pieces.

was significant. These results do not conform with the report of Stabbs (1915) that the average yield from each “tops”, “middles”, and “butts” was so nearly identical as to dispel any pronounced prejudice or preference for any portion of stalk as seed. Since the more stalks produced per hectare means greater yield, the results in the present report indicate that top seed-pieces will give a greater yield than cut-

back seed-pieces. Hence, in practice it would seem logical to use top seed-pieces.

Table 7 shows the comparative vigor between plants of top and cut-back seed-pieces of sugar cane. It may be seen that the highest stalks of cut-back seed-pieces had an average of 72.50 ± 1.2490 cm., and those of top, 71.45 ± 1.0770 cm. The average diameter of the



Fig. 7.—Showing the effects of spacing on degree of tillering and vigor of P. O. J. 2878 sugar cane at the age of about five months. Culture 1, wide-spaced and fully exposed stool, and culture 2, narrow-spaced and partially exposed stool. Note the excessive tillering of wide-spaced and fully exposed stool. Also note the insignificant difference between the height and diameter of stalks of the two cultures. Both cultures are from top seed-pieces.

highest stalks of plants of cut-back seed-pieces was 2.51 ± 0.0227 cm. and those of top seed-pieces was 2.48 ± 0.0222 cm., giving an insignificant difference in the height and diameter of stalks. The possible explanation for this insignificant difference is that there were more tillers per stool of top than cut-back seed-pieces, hence, there would be greater competition for any available synthesized food material for the plants of the top than of the cut-back seed-pieces, resulting in a slight decrease in the vigor of the plants of the top seed-pieces.

Table 8 shows the effects on the degree of tillering of spacing of sugar cane.

Wide-spread and fully exposed plants of both top and cut-back seed-pieces showed better tillering than close-spaced and partially exposed plants. An average of 10.60 ± 0.4661 tillers per stool was recorded from wide-spaced and fully exposed plants of top seed-pieces and an

average of only 5.60 ± 0.1811 tillers from close-spaced and partially exposed top seed-pieces, giving a very significant difference of about 5 tillers. The wide-spaced and fully exposed plants of cut-back seed-pieces produced an average of 7.20 ± 0.272 tillers and the close-spaced and partially exposed plants an average of 6.10 ± 0.1890 tillers with an insignificant difference of about one tiller. The very significant

difference obtained from top seed-pieces indicates that the wider the spacing and the more exposed the plants the higher the production of tillers. The better exposure of the leaves resulting in more photosynthetic activities and better aëration in wide-spaced and fully exposed plants may account for the better tillering of these plants.

In table 9 may be seen the effects of spacing on vigor of sugar cane. Close-spaced and partially exposed plants of both top and cut-back seed-pieces had longer diameter of stalks than wide-spaced and fully exposed plants. The close-spaced plants of top seed-pieces were



Fig. 8.—Showing the comparative degree of tillering and vigor of plants of the different sections of the cane at the age of about five months. From left to right: culture 1, stool of top seed-piece; culture 2, stool of middle seed-piece; and culture 3, stool of butt seed-piece. Note the descending order in the degree of tillering from cultures 1 to 3.

on the average about 16 cm. taller than the wide-spaced plants, and had on an average, about 0.22 cm. greater diameter. The differences in both cases were significant. The close-spaced plants of cut-back seed-pieces were on an average, about 16 cm. taller than the wide-spaced ones, and had about 0.2 cm. greater diameter. The difference in each case was significant. The results of this experiment are shown also in figure 7.

Experiment 5: a study of the comparative degree of tillering and vigor between plants of different sections of the cane. The results

of this experiment are presented in table 10 and in figures and 6a, 6b and 8. Table 10 presents the comparative degree of tillering between plants of the different sections of the cane. It may be noted that there was a descending order in the degree of tillering from plants of top to butt seed-pieces with a significant difference of about 2 tillers, and a significant difference of about 1 tiller between plants of the middle and butt seed-pieces. These differences are illustrated in figure 8 and graphically in figure 6b. These results verified the findings of the previous experiment.

The comparative vigor between plants of the different sections of the cane are presented in table 11. It may be noted in this table that there was an inconsistent difference in the height of stalks of different sections of the cane. On an average, the stalks of the butt seed-pieces, were about three cm. taller than those of the top and these had an average height of about three cm. more than the plants of the middle seed-pieces. The difference in height of stalks of the different sections of the cane was insignificant. Table 11 also shows that the plants of the top portion of the cane had the longest diameter, and plants of the butt, the smallest. The difference in diameter between plants of the different sections of the cane was insignificant. These results are in agreement with those of the previous experiment.

SUMMARY AND CONCLUSIONS

1. In the College of Agriculture experimental field, P.O.J. 2878 variety of sugar cane planted during January, February, and March, 1932, showed a very poor stand. With the object of attempting to improve the germination of seed-pieces of this important variety of sugar cane, experiments were conducted to determine the cause or causes of this poor stand. The results reported in this paper were obtained under controlled experimental conditions in the laboratory and in the plots in the field with adequate replications. The conclusions drawn should be fairly reliable.

2. In seed-pieces that had been allowed to stand for three days or more, top seed-pieces gave a decidedly better germination than cut-back seed-pieces. Under laboratory conditions the average percentage of the various treatments was 86.5 for top seed-pieces and 52.5 for cut-back seed-pieces. Under field conditions, with moisture con-

tent below the optimum, there was an increase of 9.37 per cent of germination of top over cut-back seed-pieces. This uniform superiority of germination of top over cut-back seed-pieces is worthy of note, as it can be concluded that contrary to general belief, the germination of cut-back seed-pieces is not so good as top seed-pieces.

3. The factors responsible for the poor stand in the field were pineapple disease caused by *Thielaviopsis paradoxa* (de Seynes Höh.), inadequate moisture for germination, and the use of cut-back seed-pieces which were more seriously attacked by the pineapple disease than the top seed-pieces.

4. Of the soaking solutions, lime-magnesium sulfate gave the best results. Seed-pieces can be treated with lime-magnesium sulfate solution on a large scale and economically, as it costs less than three pesos (₱3.00) per hectare to treat the seed-pieces.

5. Under laboratory conditions, water gave inconsistent results; seed-pieces soaked in water for 24 and 48 hours gave the same percentage of germination as the unsoaked or control; and those soaked in the same medium for 12 and 36 hours gave an increase of germination over the control of 10 per cent and 7.5 per cent, respectively. Soaking in water for more than 48 hours was detrimental to cut-back seed-pieces.

Under field conditions with moisture content below the optimum, seed-pieces soaked in running water gave better germination than the control; stagnant water was found to be detrimental to the seed-pieces.

These results indicate that soaking seed-pieces in running water to insure higher percentage of germination should be resorted to during the dry months of January, February, March, and April; but in September, October, and November when there is requisite moisture for germination, soaking is unnecessary as the bud can obtain from the soil all the necessary moisture for germination and subsequent growth.

6. The percentage of germination of both top and cut-back seed-pieces was much higher under laboratory than under field conditions; it may be that the moisture content of the soil was the determining factor for this result.

7. None of the seed-pieces germinated in soil containing 10 per cent moisture. In soil containing 15 per cent moisture none of the butt and middle seed-pieces germinated; top seed-pieces gave 70 per cent germination. In soil containing 20 per cent moisture, a fairly

good germination was obtained from the different sections of the cane; top, middle, and butt seed-pieces gave 100, 80, and 60 per cent germination, respectively. A still higher percentage of germination was obtained in soil containing 25 per cent moisture. Seed-pieces germinated earlier and produced more shoots in soil containing 20 to 25 per cent moisture.

These results indicate that 20 per cent moisture was approaching the optimum and that 25 per cent was about the optimum moisture for seed-piece germination and normal growth of plants of P.O.J. 2878 sugar cane. It may be concluded from these results that any section of the cane will give fairly good germination provided it is planted soon after it is cut from the parent plant and that optimum moisture for germination is present. Under planting conditions with soil moisture below the optimum (20 to 25 per cent), top seed-pieces are desirable.

8. Top seed-pieces produced more tillers than cut-back seed-pieces. Since the more stalk to the hectare means the greater yield, these results indicate that top seed-pieces will give greater yield than cut-back seed-pieces. Hence, in practice it would seem best to use top seed-pieces.

9. The cut-back seed-pieces produced more vigorous plants than the top, but the difference was insignificant.

10. Wide-spaced and fully exposed plants showed better tillering than close-spaced and partially exposed plants. The difference was very significant.

11. Close-spaced and partially exposed plants were more vigorous than wide-spaced and fully exposed plants.

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TABLE 1

The comparative germination under laboratory conditions between top and cut-back seed-pieces of sugar cane soaked for varying lengths of time in different media

CULTURE NO.	TREATMENT		KINDS OF SEED-PIECES	NUMBER OF SEED-PIECES		PERCENTAGE OF GERMINATION	PERCENTAGE INCREASE OF TOP OVER CUT-BACK
	Soaking media	Number of hours soaked		Planted	Germinated		
I	Lime-magnesium sulfate solution	12	Top	20	17	85	35
			Cut-back	20	10	50	
II	Water	12	Top	20	19	95	45
			Cut-back	20	10	50	
III	Lime-magnesium sulfate solution	24	Top	20	16	80	20
			Cut-back	20	12	60	
IV	Water	24	Top	20	16	80	35
			Cut-back	20	9	45	
V	Lime-magnesium sulfate solution	36	Top	20	17	85	20
			Cut-back	20	13	65	
VI	Water	36	Top	20	17	85	30
			Cut-back	20	11	55	
VII	Lime-magnesium sulfate solution	48	Top	20	17	85	5
			Cut-back	20	16	80	
VIII	Water	48	Top	20	18	90	55
			Cut-back	20	7	35	
IX	Unsoaked	—	Top	40	32	80	35
			Cut-back	40	18	45	

TABLE 2

The effects on germination under laboratory conditions of soaking seed-pieces of sugar cane for varying lengths of time in different media

CULTURE No.	TREATMENT		KIND OF SEED-PIECES	NUMBER OF SEED-PIECES		PERCENTAGE OF GERMINATION		PERCENTAGE INCREASE OF TREATED OVER CONTROL
	Soaking media	Number of hours soaked		Planted	Germi- nated	Actual	Average	
I	Lime-mag- nesium sulfate solution	12	Top	20	17	85	67.50	5.00
			Cut-back	20	10	50		
II	Water	12	Top	20	19	95	72.50	10.00
			Cut-back	20	10	50		
III	Lime-mag- nesium sulfate solution	24	Top	20	16	80	70.00	7.50
			Cut-back	20	12	60		
IV	Water	24	Top	20	16	80	62.50	—
			Cut-back	20	9	45		
V	Lime-mag- nesium sulfate solution	36	Top	20	17	85	75.00	12.50
			Cut-back	20	13	65		
VI	Water	36	Top	20	17	85	70.00	7.50
			Cut-back	20	11	55		
VII	Lime-mag- nesium sulfate solution	48	Top	20	17	85	82.50	20.00
			Cut-back	20	16	80		
VIII	Water	48	Top	20	18	90	62.50	—
			Cut-back	20	7	35		
IX	Unsoaked (control)	—	Top	40	32	80	62.50	—
			Cut-back	40	18	45		

TABLE 3

The comparative germination under field conditions between top and cut-back seed-pieces of sugar cane soaked in different media

CULTURE NO.	TREATMENT		KIND OF SEED-PIECES	NUMBER OF SEED-PIECES		PERCENTAGE OF GERMINATION	PERCENTAGE INCREASE OF TOP OVER CUT-BACK
	Soaking media	Number of hours soaked		Planted	Germinated		
I	Lime-magnesium sulfate solution	48	Top	1,264	391	30.93	16.11
II	Running water	48	Top	794	191	24.19	9.37
III	Stagnant water	48	Top	1,328	115	8.66	—6.16
IV	Unsoaked	—	Top	428	90	21.02	6.20
V	Running water	48	Cut-back	1,302	193	14.82	—

TABLE 4

The effects on germination under field conditions of soaking seed-pieces of sugar cane in different media

CULTURE NO.	TREATMENT		KIND OF SEED-PIECES	NUMBER OF SEED-PIECES		PERCENTAGE OF GERMINATION	PERCENTAGE INCREASE OF TREATED OVER CONTROL
	Soaking media	Number of hours soaked		Planted	Germinated		
I	Lime-magnesium sulfate solution	48	Top	1,264	391	30.93	9.91
II	Running water	48	Top	794	192	24.19	3.17
III	Stagnant water	48	Top	1,328	115	8.66	—12.36
IV	Unsoaked (control)	—	Top	428	90	21.02	—

TABLE 5

The effects of varying amounts of moisture in the soil on germination and vigor of plants of the different sections of the cane

CULTURE NO.	PERCENTAGE OF MOISTURE IN SOIL	KIND OF SEED-PIECES	NUMBER OF SEED-PIECES		PERCENTAGE OF GERMINATION	NUMBER OF SHOOTS		REMARKS
			Planted	Germinated		Total	Average	
I	10	Butt	10	0	0	0	0	The seed-pieces were dry and hollow and produced neither root nor shoot.
		Middle	10	0	0	0	0	" " "
		Top	10	0	0	0	0	" " "
II	15	Butt	10	0	0	0	0	Three seed-pieces showed sprouting of roots and shoots; the rest were dry.
		Middle	10	0	0	0	0	Eight seed-pieces showed sprouting of roots and shoots and the rest were dry.
		Top	10	7	70	9	1.28	Some of the shoots were drying.
III	20	Butt	10	6	60	6	1.00	" " "
		Middle	10	8	80	12	1.50	One shoot was dead and the rest were normal.
		Top	10	10	100	22	2.20	Some of the shoots were wilting and the rest were normal.
IV	25	Butt	10	10	100	11	1.10	Plants were vigorous.
		Middle	10	8	80	11	1.37	" " "
		Top	10	10	100	25	2.50	" " "

TABLE 6

The comparative degree of tillering between plants of top and cut-back seed-pieces of sugar cane grown from March 7 to August 3, 1932

CULTURE NO.	KIND OF SEED-PIECES	NUMBER OF STALKS PER STOOL IN 60 STOOLS
I	Top	8.10 ± 0.2870
II	Cut-back	6.70 ± 0.1630
Difference		1.40 ± 0.33

TABLE 7

The comparative vigor of plants of top and cut-back seed-pieces of sugar cane grown from March 7 to August 3, 1932

CULTURE NO.	KIND OF SEED-PIECES	AVERAGE OF 60 STALKS	
		Height	Diameter
		cm.	cm.
I	Top	71.45 ± 1.0770	2.48 ± 0.0222
II	Cut-back	72.50 ± 1.2490	2.51 ± 0.0227
Difference		1.05 ± 1.649	0.03 ± 0.0324

TABLE 8

The effects on degree of tillering of spacing of sugar cane grown from March 7 to August 3, 1932

CULTURE NO.	TREATMENT	KIND OF SEED-PIECES	NUMBER OF STALKS	NUMBER OF STALKS PER STOOL
I	Fully exposed	Top	18	10.60 ± 0.4661
	Partially exposed	Top	42	5.60 ± 0.1811
Difference		—	—	5.00 ± 0.4990
II	Fully exposed	Cut-back	18	7.20 ± 0.2720
	Partially exposed	Cut-back	42	6.10 ± 0.1890
Difference		—	—	1.10 ± 0.3310

TABLE 9

The effects on vigor of spacing of sugar cane grown from March 7 to August 3, 1932

CULTURE NO.	KIND OF SEED-PIECES	TREATMENT	NUMBER OF STALKS	AVERAGE	
				Height in cm.	Diameter in cm.
I	Top	Partially exposed	42	76.20 ± 1.1860	2.55 ± 0.0247
		Fully exposed	18	60.37 ± 1.1470	2.33 ± 0.0331
		Difference		15.83 ± 1.6520	0.22 ± 0.0413
II	Cut-back	Partially exposed	42	77.10 ± 1.4050	2.56 ± 0.0264
		Fully exposed	18	61.76 ± 1.6460	2.36 ± 0.0347
		Difference		15.34 ± 2.164	0.20 ± 0.0437

TABLE 10

The comparative degree of tillering between plants of different sections of the cane grown from April 14 to August 3, 1932

CULTURE NO.	KINDS OF SEED-PIECES	NUMBER OF STALKS PER STOOL IN 9 STOOLS
I	Top	7.90 ± 0.0311
II	Middle	6.00 ± 0.0037
	Difference	1.90 ± 0.0313
II	Middle	6.00 ± 0.0037
III	Butt	5.10 ± 0.0272
	Difference	0.90 ± 0.00274

TABLE 11

The comparative vigor between plants of different sections of sugar cane grown from April 14 to August 3, 1932

CULTURE NO.	KINDS OF SEED-PIECES	AVERAGE	
		Height in cm.	Diameter in cm.
I	Top	63.70 ± 2.0665	2.68 ± 0.0246
III	Butt	66.00 ± 2.8814	2.64 ± 0.0283
	Difference	-2.30 ± 3.5400	0.04 ± 0.0376
II	Middle	60.43 ± 1.3559	2.66 ± 0.0473
III	Butt	66.00 ± 2.8814	2.64 ± 0.0283
	Difference	-5.57 ± 3.1700	0.02 ± 0.0551

THE USE OF ALCOHOL AS FUEL FOR SMALL GAS ENGINES ¹

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WITH TWO CHARTS

Not only is the use of alcohol increasing in the arts and the industries; it has entered the motor world also. In 1922, large sugar centrals in the Philippines began to use alcohol to run tractors. Since that year its use for tractor fuel has increased, as is shown by the establishment of distilleries in many large centrals for the production of motor alcohol. The most recent power-alcohol fuel in the Philippine market is gasanol. A large part of its composition is rectified alcohol. Unquestionably, alcohol as a fuel—mixed or not mixed with other fuels—is gaining recognition in the Philippine market; it is keeping pace with the other motor fuels.

It was the object of the writers in this investigation to determine the feasibility of using denatured alcohol and gasanol as fuels for small stationary gas engines.

Studies on alcohol as fuel for tractor engines have been conducted, but very little study has been made on it as fuel for small stationary gas engines.

Teodoro (1931) in his work on "Alcohol as a fuel for tractor engines" obtained the following results ²:

1. Water injections increased the volumetric efficiency; lowered the radiator temperature; developed maximum power; and prevented knocking.

2. Tractors designed to run on kerosene and gasoline were made to run on alcohol.

¹ Portions of the material in this paper were included by the junior author in a thesis presented in March, 1932, for graduation with the degree of Bachelor of Agriculture, from the College of Agriculture No. 342. The thesis was prepared in the Department of Agricultural Engineering under the direction of Dr. A. L. Teodoro.

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² TEODORO, A. L. 1931. A comparative study of alcohol, gasoline, and kerosene as fuels for tractor engines. *THE PHILIPPINE AGRICULTURIST* 20: 295-327. *Fig. 1-4; charts 1-4.*

3. With the exception of the Fordson tractor, enlargement of the carburetor jet was necessary in all tests using alcohol.

4. The consumption of fuel per brake horse power was greater for alcohol fuel than for either gasoline or kerosene.

5. The relative brake thermal efficiencies were generally higher for alcohol fuels than for either gasoline or kerosene.

6. Operation with alcohol fuel in these types of engines was characterized by smooth running, steady pull, and absence of overheating, pre-ignition and knocking. No sign of corrosion was noted."

The work reported in this paper was begun in June, 1931 and ended on December 30, 1931. The experiments were performed in the laboratory of the Department of Agricultural Engineering, College of Agriculture.

MATERIALS AND METHODS

The engines used

Four engines were used: three International engines rated at 1-1/2 H.P., 3 H. P., and 6 H. P., respectively, and a 4 H. P. Cushman engine. They were used chiefly for class studies. Table 1 shows the measurements of the different engines used.

International engines. These engines are manufactured by the International Harvester Company of Chicago. They are distributed in the Islands by the International Harvester Company of the Philippines. The 1-1/2 H. P. engine tested in this work is used in the Department of Engineering for running a small dynamo. It is a 4-cycle engine and was designed for kerosene as fuel. The carburetor has three chambers, one for gasoline, another for kerosene, and a third one for the overflow. The overflow is drained into the fuel tank by gravity. A positively driven pump supplies fuel to the carburetor from the fuel tank. The gasoline and kerosene chambers have each a needle valve. There is a third needle valve in the carburetor which regulates the water that may be injected into the cylinder. A Wico Type "EK" high tension magneto is used. The lubrication of the piston is accomplished by means of sight feed system. The bearings are lubricated by grease placed in the grease cups. It has a throttling governor and the cooling system is of the water hopper type.

The 1-1/2 H. P. and 3 H. P. International engines are essentially the same in construction. The 6 H. P. engine, however, has only two needle valves in the carburetor. One valve regulates the amount of fuel used and the other limits the amount of water that

may be used for injections. A shifting mixer valve is provided showing valve positions for starting, for running, and for draining. A rotary magneto "R" type and an igniter block are used.

Cushman engine. The Cushman engine has a vertical cylinder, and uses gasoline but not kerosene. The carburetor is of the Schebler type, with a fuel needle valve and an air regulator. The gasoline tank supplies fuel by gravity to the carburetor through a pipe. Like the other engines, the intake valve works automatically, but it is enclosed in a tube at the cylinder head. A priming cup is provided. The ignition system consists of a high tension coil and battery. The lubrication of the piston is by means of the sight feed system, and the bearings by the splash system. The governor is of the throttle type. The engine is hopper cooled.

The 3 H. P. I. H. C. engine was the newest engine in the laboratory, being only a few weeks old when the tests were made.

The fuels used

Kerosene, gasoline, gasanol, and denatured alcohol were used in the tests.

Kerosene. Kerosene and gasoline were used in this work for comparison with alcohol and gasanol. There were three brands of kerosene used: the Carabao brand, the Gallo brand, and the Rizal brand. No precaution was taken to test each one separately. A heating value of 19,876 B.t.u. per pound was used.

Gasoline. Two brands of gasoline were used. A Shell brand was used in testing the 3 and 6 H. P. engines and a Socony brand in the other two engines. The heating values used 20,150 B.t.u. per pound.

Gasanol. The gasanol fuel was manufactured and distributed exclusively by La Tondeña Inc., Manila. The composition of this fuel, as given by the manufacturer, is as follows:

Rectified alcohol (189 proof)	50 per cent by volume
Commercial ether	5-10 per cent
Gasoline	40-45 per cent

When allowed to stand for some time, the mixture almost separated into two layers, and when stirred, it became cloudy and turbid. Its specific gravity was 0.7609 and the heating value, 15,600 B.t.u. per pound.

Alcohol. No tests were made with pure ethyl alcohol as it is too expensive to use for fuel. Denatured alcohol, trade mark Gallo, was used in the tests. The solution was clear with no signs of turbidity. Its specific gravity was 0.8140 and the heating value 11,130 B.t.u. per pound.

When the term alcohol is used in this paper, this fuel is meant.

Dynamometer used

The dynamometer used was a Froude hydraulic dynamometer of the non-reversible type. It is manufactured by Heenan & Froude, Ltd., Worcester, England. Its size is D. P. \times 4 and it can absorb a maximum of 400 horse power at 2700 r.p.m.

The brake horse power of the engine tested was calculated from the following formula:

$$B.H.P. = \frac{WN}{2400}$$

where:

B.H.P. = Brake horse power.

W = Load in pounds read at the circular scale dial at the end of the dynamometer arm.

N. = r.p.m. of the dynamometer.

2400 = the numerical constant for the device.

The load in pounds was read directly on the circular scale dial of the dynamometer; the smallest division of the scale was 0.25 of a pound. The r.p.m. of the dynamometer was approximately indicated by Harding's tachometer and recorded by Harding's revolution counter accurate to 10 r.p.m. The reading of the revolution counter was checked by the tachometer. The smallest division of the tachometer is 25 r.p.m.

In line with the main shaft of the dynamometer was coupled another shaft carrying a 12-inch wooden pulley. This shaft is supported by two Timken roller bearings assembled in self-aligning blocks. The power of the engine was transmitted to the dynamometer by means of a 4-inch rubberized canvas belt.

The water supplied to the dynamometer came from the College reservoir which has a pressure head of about 45 feet.

Fuel-measuring device used

The fuel consumed was measured by No. 565805 Bench scale manufactured by Toledo Scale Company of Toledo, Ohio, U. S. A. The balance is capable of weighing a total of 25 pounds, 20 pounds

of which are recorded on two beams, 10 pounds on each, with sliding poises; and the 5 pounds are recorded on a scale dial graduated in hundredths of a pound over which there moves a pointer.

Other measuring devices used

Stop watch. The time was recorded by a stop watch which read to 0.2 of a second.

Speed counter. The r.p.m. of the dynamometer could be read in Harding's revolution counter connected to its shaft. This revolution counter, however, is accurate only to 10 r.p.m. A speed counter which gave a reading accurate to 1 r.p.m. was used to check the dynamometer speed.

Procedure of tests

Adjustment of the engine. Before the engines were used, precaution was taken that every part was in good working order. The carburetors, the inlet valves, the exhaust valves, and the cylinders were thoroughly cleaned. The ignition and valve timings were carefully checked. All oil feeders and grease cups were carefully filled to required capacities. The number of drops of oil in the sight feed was regulated to seven per minute. The water hoppers in the case of the International engines were kept two-thirds full at the beginning of the tests. In the Cushman engine, the cooling of the cylinder was effected by a continuous flow of water from a separate hopper. Since the water from the tank flowed to the engine by gravity, the tank was placed higher than the cylinder.

Whenever a change of fuel was made, the same precautions were taken.

Adjustment of the balance. As it was necessary to weigh the fuel consumed, it was placed in a tank on the platform of the scale balance. The amount consumed per unit was found from the readings in the scale. A tube connected the tank to the pump of the engine so that the fuel was supplied to the carburetor by pumping. Another tube connected the overflow chamber to the tank on the balance. The flow was by gravity. Hence, the balance had to be set lower than the level of the carburetor.

Adjustment of the dynamometer. The dynamometer was properly adjusted before using. The first step was to disconnect it from the engine by removing the belt. The static balance weight *S* was then suspended upon the hanger bolt beneath the spring balance. Adjustment of the hand wheel *H* on the balance followed,

making the arm centers approximately horizontal. This was shown by a level indicator connected to the arm centers. The power adjusting gear *P* was then screwed as far into the machine as was possible. Adjustment on the circular scale dial followed making the pointer to register zero; the slots on the pointer facilitated the needed adjustment. Water was made to flow into the machine through the inlet valve fully opened. The opening of the outlet valve was regulated so that the temperature of the outflow did not rise over 60°C. (140°F.). When all these adjustments had been made, the dynamometer was ready for work. The arm centers were adjusted horizontally at all loads.

The test. After making the necessary adjustments on the engine, on the balance, and on the dynamometer, the tests were performed. All the engines used were started on gasoline. Sufficient time was given to warm up the engines before any test was started. The needle valve was adjusted to the minimum opening which gave the engine a constant speed at any desired load.

The power of the engine was transmitted to the dynamometer through a belt. The desired load was obtained by screwing or unscrewing the power-adjusting gear of the dynamometer. For each fuel a series of tests was made to represent no load, half load, and full load adjustments. When the power gear was all screwed in, the engine was considered to carry no load. When the power gear was unscrewed slowly and the engine labored so hard that the r.p.m. began to decrease, maximum load was considered to have been reached. Tests were made only when the engine acquired a uniform speed and worked smoothly. The amount of fuel consumed was taken every five minutes. The consumption was obtained from the difference of any two consecutive readings in the scale. The r.p.m. of the engine and of the dynamometer were determined every five minutes with the use of the speed counter. Six to eight tests each of five minutes duration were made in each load.

RESULTS AND DISCUSSIONS

Results observed

General observations made. All the engines used were found to run on alcohol and gasanol. In all tests, the cooling water boiled, so no measurement of the temperature was taken. Water injections were made whenever knocking was observed. This usually occurred at or near the full load. No knocking was heard in any engine at

any load with the use of either alcohol or gasanol. Knocking was very much in evidence in the case of the 3 H. P. International engine, when kerosene and gasoline were used. When water was injected in the case of the 6 h.p. engine at full load, knocking lessened somewhat but the engine slowed down causing a decrease in power. So the engine was allowed to carry the full load without water injection. In the case, however, of the 1½ and 3 H. P. I. H. C. engines, the injection of water at this point not only minimized knocking but also helped increase the power. It was thought that the water needle valve in the 6 h. p. engine was defective. It is possible that a slight turning of the valve allowed too much water to get in.

Knocking of the engine near the full load may be due to pre-ignition. The operating temperature of the piston at this point might be so high that spontaneous ignition takes place when the charge comes in contact with the hot walls. It is therefore possible for the engine to fire before the regular electric ignition takes place. The presence of injected water decreases the operating temperature because of evaporation and superheating of the steam. It may also loosen the accumulated particles of carbon on the surfaces of the piston and cylinder. Their presence at a very high temperature may render them incandescent causing an early firing of the charge.

Knocking, thus eliminated, causes an increase in power for the reason that knocking itself is an unnecessary loss of power. Greater power is further attained because the volumetric efficiency is increased when the operating temperature is reduced. When the temperature is high, only a small amount of fuel will be taken in owing to expansion. Less charge means less power developed.

The presence of water in alcohol and in gasanol made it unnecessary to open the water needle valve of the engine even when operating beyond the full load capacity.

Each of the International engines ran smoothly on all the fuels. The Cushman engine, however, exhibited a different behavior when alcohol was used. Its operation was not very smooth. The jet-opening is small being designed for gasoline, only. The engine could not be made to run unless the air passage was closed about two-thirds. Corrosion of pistons and cylinder walls was not observed during the length of time the engines were tested.

Maximum power developed. It is interesting to note that in every engine, except the Cushman engine, alcohol followed by gasanol produced a higher maximum power than either gasoline or kero-

sene. Table 3 shows the maximum power that was developed by each engine using four different kinds of fuel.

In the Cushman engine, the fuel that developed the highest maximum power was gasanol. A poor result was obtained when alcohol was used because the fuel jet was not large enough to admit the required full charge of the fuel. It was found to be necessary to partly close the air throttle in order to balance the amount of liquid fuel that got in. With open air throttle, the mixture was so lean that combustion could not take place.

It will also be noted in the results that the maximum power developed by all fuels in the 1½ and 3 H. P. engines passed above their rated power, but in the 4 H. P. and 6 H. P. engines, the opposite was true. The reason may be due to the fact that the 4 H. P. and 6 H. P. engines were old machines.

Comparison of the consumption in liters per hour to the load

Table 3 shows the consumption in pounds per 5 minutes and in liters per hour for the different loads. It may be noticed in the table that the greater the load in brake horse power, the higher the consumption in liters per hour. This was true for all fuels and in all engines.

Comparison of the consumption in pounds per brake horse power hour to the load

The consumption in pounds per brake horse power hour is shown in table 3 and in chart 1. This chart shows that the greater the load applied the lower was the consumption of fuel in pounds per horse power hour.

Table 4 shows the relative consumption at half loads and at full loads. The order of economy in general is gasoline, kerosene, gasanol, and alcohol. The 6 h. p. I. H. C. engine, however, was found to be more economical on gasanol than on kerosene.

Brake thermal efficiencies

The brake thermal efficiencies of the fuel were calculated from the formula:

$$B.T.E. = \frac{2545}{W \times H} \times 100$$

where

$B.T.E.$ = Brake thermal efficiency.

2545 = B.t.u., the heat equivalent to 1 horse power hour.

W = The fuel consumption in pounds per brake horse power hour.

H = Heating value of the fuel in B.t.u. per pound.



Chart 1.—Showing relation between consumption of fuel in pounds per brake horsepower-hour and load in horsepower.

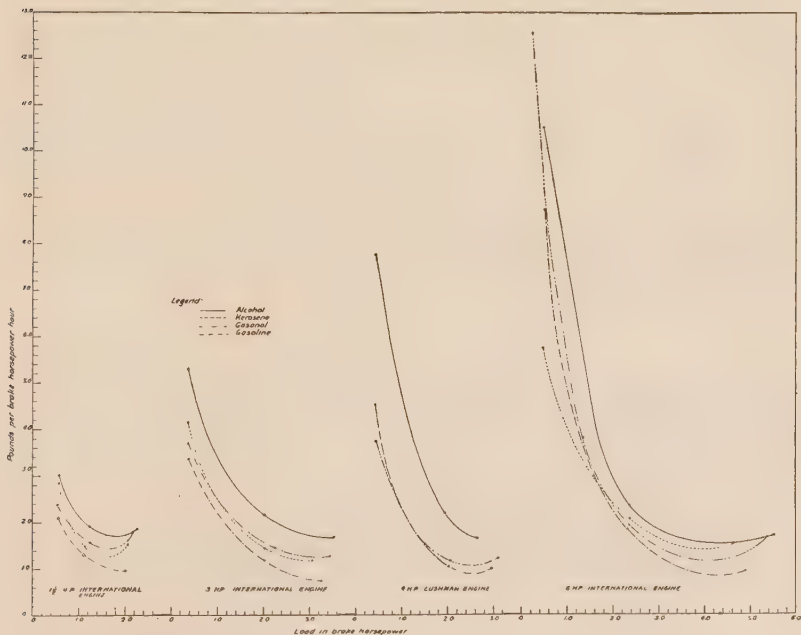


Chart 2.—Showing relation between brake thermal efficiency and load in horsepower.

Table 3 shows the calculated brake thermal efficiencies of all the fuels for every load. It will be noted in the results obtained from the International engines, that gasoline had a higher brake thermal efficiency than any other fuel at maximum load. At half loads and lower loads, however, alcohol and gasanol had a greater efficiency than either gasoline or kerosene. Chart 2 illustrates these results. On the whole, it may be generalized that alcohol and gasanol produce relatively higher brake thermal efficiencies than the other fuels with kerosene producing the least.

The results obtained using the Cushman engine showed gasanol as the most efficient fuel. The results were unfair for alcohol because the carburetor was not well adapted for its use.

Relative costs of the four fuels used

Table 5 shows the relative amount of consumption per brake horse power hour for alcohol, gasanol, and gasoline, using kerosene as the basis of comparison. The same table shows the relative costs of the different fuels considering the price of kerosene as unity. Relative cost means a factor by which the cost of kerosene must be multiplied to find the price that may be paid for other fuels to give the same power cost. If, for example, 0.75 liter of kerosene is required to run the 1½ H. P. International at full load per brake horse power hour, and 1.27 times as much alcohol is needed to produce the same power, about 0.95 liter of alcohol would be used. With kerosene at 7 centavos per liter the cost of running with kerosene will be 0.75×7 or 5.25 centavos. To get the equivalent cost of alcohol 5.25 is divided by 0.59 and 5.52 centavos per liter is obtained. That is, to be as economical as kerosene, alcohol must be sold at 5.52 centavos per liter. This figure is obtained by multiplying 7 centavos by 0.79, a factor which is found in table 5.

Table 5 shows the different factors that may be used for ratios by weight and by volume.

SUMMARY OF CONCLUSIONS

The calculations and results obtained in the tests may be summarized as follows:

1. All the engines used were found to run on alcohol and gasanol.
2. In all tests, the cooling water boiled.
3. Water injections were made only in the 3 H. P. International engine when run on kerosene and gasoline. Knocking in this engine

stopped when water injection was made. A slight knocking was observed in the 6 H. P. engine when run on kerosene. Water injection in this engine removed the knock but decreased the power.

4. All the engines ran smoothly on alcohol and gasanol, except the H. P. Cushman engine which did not run smoothly on alcohol. The carburetor was found imperfect for this fuel.

5. Alcohol and gasanol developed a higher maximum power in the International engines than either gasoline or kerosene. In the Cushman engine, gasanol produced the highest maximum power and alcohol, the least. The carburetor of this engine was not suited to alcohol fuels.

6. The 1½ H. P. and 3 H. P. engines developed powers higher than their rated load. The 4 H. P. and 6 H. P. engines, however, failed to reach their rated powers.

7. The consumption in liters per hour of all fuels increased with the load.

8. The consumption in pounds per brake horse power hour or liters per brake horse power hour decreased with an increase in the load up to the most economical point.

9. There was a greater consumption of alcohol and gasanol than either gasoline or kerosene for the same load. In the 6 H. P. engines, however, there was more consumption of alcohol and kerosene than gasanol and gasoline.

10. At maximum load, gasoline produced a higher brake thermal efficiency in the International engines than the other fuels, with alcohol and gasanol following closely. On the whole, however, the relative brake thermal efficiencies of alcohol and gasanol were higher than those of gasoline or kerosene. In the Cushman engine, gasanol produced the highest brake thermal efficiency.

11. As to whether alcohol or gasanol is the most economical to use largely depends on the current market prices of these fuels. At the time of these tests the most economical fuel for the International engines was kerosene. For the Cushman engine, gasanol was the most economical.

12. The corrosive effects of these fuels were not observed; so the question of whether it will be economical in the long run to operate the engines on alcohol or on gasanol remains for further study.

TABLE 1

Showing the measurements of the different engines used

MAKE OF ENGINE	ENGINE SPEED ^a	DIAMETER OF PULLEY	BORE OF CYLINDER ^a	STROKE OF PISTON ^a	PISTON DISPLACEMENT	CYLINDER CLEARANCE	COMPRESSION RATIO
	r.p.m.	inches	inches	inches	cu. in.	cu. in.	
1½ H.P. International	500	7	3-5/8	4-1/2	46.4	14.65	4.19
3 H.P. International	600	8	4-1/8	5-1/2	68.6	21.70	4.16
4 H.P. Cushman	800	6	4	4	50.3	13.90	4.63
6 H.P. International	550	14	4-3/4	8	142.0	45.06	4.15

^a Data taken from the catalogue given by the manufacturer of the engine.

TABLE 2

Showing some of the physical properties of the fuels used

FUEL	SPECIFIC GRAVITY	HEATING VALUES
		B.t.u. per pound
Denatured alcohol	0.8140	11,130 ^a
Gasanol	0.7609	15,600 ^b
Kerosene	0.8009	19,876 ^a
Gasoline	0.7399	20,150 ^a

^a Data taken from Teodoro (1931): "Effects of variable compression ratio on the performance of tractor engine using alcohol." University of the Philippines Natural and Applied Science Bulletin 1: 187-221. *Charts 1-12.*

^b Data given by the La Tondeña, Inc. manufacturer and distributor of gasanol.

TABLE 3
Showing the results of tests in series 1, 2, 3, and 4

ENGINE	TEST NO.	DURATION OF TESTS	SPEED		WEIGHT RECORDED IN DYNAMOMETER	HORSE POWER	CONSUMPTION			BRAKE THERMAL EFFICIENCY
			Engine	Dynamometer						
							min.	r.p.m.	r.p.m.		pounds	b.h.p.	lb./5 min.	1./hour	lb./b.h.p. hour	per cent
1-1/2 H.P. International	Kerosene									
	1	40	538.80	334.00	4.00	0.557	0.137	0.935	2.948	4.35
	2	40	542.00	332.00	8.00	1.115	0.139	0.945	1.490	8.60
	3	30	495.00	298.50	16.50	2.052	0.260	1.770	1.520	8.42
	Gasoline									
	4	40	545.00	338.60	4.00	0.566	0.099	0.731	2.110	5.99
	5	40	539.25	331.75	8.00	1.108	0.121	0.873	1.310	9.65
	6	30	512.20	313.30	15.42	2.010	0.160	1.170	0.954	13.28
	Gasanol									
	7	40	564.20	338.40	4.00	0.563	0.113	0.800	2.390	6.84
	8	40	544.00	327.50	9.00	1.230	0.161	1.150	1.580	10.32
	9	30	513.20	306.20	17.00	2.168	0.323	2.310	1.781	9.17
3 H.P. International	Alcohol									
	10	40	565.60	333.60	4.00	0.550	0.140	0.930	3.020	7.57
	11	40	552.00	326.90	9.00	1.220	0.195	1.305	1.910	11.96
	12	30	525.70	310.50	17.50	2.260	0.350	2.340	1.850	12.37
	Kerosene									
	13	30	607.30	418.00	2.00	0.349	0.120	0.820	4.140	3.10
	14	30	588.00	404.16	12.00	2.025	0.243	1.660	1.443	8.89
	15	30	533.60	368.80	20.00	3.078	0.300	2.040	1.169	11.00
	Gasoline									
	16	30	602.30	412.00	2.00	0.345	0.096	0.640	3.370	3.75
	17	30	590.20	402.60	12.00	2.016	0.198	1.457	1.179	10.73
	18	30	574.40	393.00	20.00	3.273	0.200	1.472	0.732	17.29
4 H.P. Cushman	Gasanol									
	19	30	610.60	417.30	2.00	0.348	0.113	0.760	3.705	4.42
	20	30	598.50	404.60	12.00	2.243	0.246	1.960	1.463	11.18
	21	30	571.60	386.60	21.50	3.461	0.360	2.570	1.249	13.10
	Alcohol									
	22	30	608.00	412.00	2.00	0.345	0.152	1.010	5.276	4.33
	23	30	593.00	404.16	12.00	2.020	0.303	2.440	2.161	10.55
	24	30	549.10	367.80	23.00	3.525	0.493	3.300	1.681	13.60
	Gasoline									
	25	40	1006.50	504.90	2.00	0.421	0.159	1.100	4.524	2.79
	26	40	974.25	489.60	10.00	2.040	0.173	1.265	1.020	12.39
	27	30	798.20	394.70	18.00	2.960	0.243	1.790	0.985	12.81
6 H.P. International	Gasanol									
	28	40	1010.50	511.25	2.00	0.426	0.133	0.951	3.750	4.36
	29	40	992.60	500.00	10.00	2.083	0.200	1.430	1.150	14.20
	30	30	769.30	375.00	20.00	3.100	0.310	2.210	1.200	13.60
	Alcohol									
	31	40	986.60	493.50	2.00	0.410	0.265	1.780	7.756	2.95
	32	40	952.80	471.40	10.00	1.964	0.358	2.400	2.184	10.45
	33	30	745.20	362.40	17.50	2.642	0.362	2.423	1.644	13.90
	Kerosene									
	34	40	513.40	587.50	2.00	0.488	0.239	1.580	5.750	2.23
	35	40	497.60	570.00	10.00	2.370	0.405	2.740	2.055	6.24
	36	30	450.80	510.00	22.50	4.628	0.648	4.210	1.522	8.42
6 H.P. International	Gasoline									
	37	40	498.24	571.24	1.00	0.238	0.250	1.770	12.550	1.01
	38	40	490.40	561.25	10.00	2.335	0.351	2.570	1.804	7.00
	39	30	452.00	520.00	22.70	4.907	0.378	2.810	0.925	13.65
	Gasanol									
	40	40	517.40	595.00	2.00	0.495	0.360	2.580	8.730	1.87
	41	40	495.50	565.00	10.00	2.355	0.378	2.700	1.918	8.52
	42	30	443.00	496.00	26.00	5.380	0.607	4.330	1.656	9.86
	Alcohol									
	43	40	502.10	580.00	2.00	0.483	0.424	2.840	10.525	2.17
	44	40	502.40	575.00	10.00	2.386	0.484	3.110	2.330	9.81
	45	30	470.30	531.70	25.00	5.535	0.777	5.200	1.682	13.60

TABLE 4

Showing the relative consumption at half load and at full load ^a

ENGINE	LOAD	KEROSENE		GASOLINE		GASANOL		ALCOHOL	
		lb./b.h.p. hour	l./b.h.p. hour	lb./b.h.p. hour	l./b.h.p. hour	lb./b.h.p. hour	l./b.h.p. hour	lb./b.h.p. hour	l./b.h.p. hour
1-1/2 H.P. International	Half	1.64	0.94	1.42	0.87	1.74	1.04	2.16	1.21
	Full	1.32	0.75	0.93	0.57	1.53	0.91	1.71	0.95
3 H.P. International	Half	1.95	1.11	1.65	1.01	2.05	1.22	2.80	1.56
	Full	1.17	0.66	0.78	0.48	1.24	0.74	1.75	0.98
4 H.P. Cushman	Half	—	—	2.04	1.25	2.04	1.21	3.45	1.93
	Full	—	—	0.91	0.56	1.07	0.64	1.71	0.95
6 H.P. International	Half	2.45	1.39	2.19	1.34	2.30	1.37	2.80	1.56
	Full	1.50	0.85	1.06	0.65	1.27	0.76	1.60	0.89

^a Data derived from charts 1 and 2.

TABLE 5
*Showing the equivalent amounts of fuel used in terms of kerosene per brake horse power hour
 for half load and for full load*

ENGINE	LOAD	GASOLINE				GASANOL				ALCOHOL			
		Ratio of fuel used		Relative cost ^a		Ratio of fuel used		Relative cost ^a		Ratio of fuel used		Relative cost ^a	
		By wt.	By vol.	By wt.	By vol.	By wt.	By vol.	By wt.	By vol.	By wt.	By vol.	By wt.	By vol.
1-1/2 H.P. International	Half	0.87	0.93	1.16	1.08	1.06	1.11	0.94	0.90	1.31	1.29	0.76	0.77
	Full	0.71	0.76	1.42	1.32	1.16	1.21	0.86	0.83	1.29	1.27	0.77	0.79
3 H.P. International	Half	0.85	0.91	1.19	1.10	1.05	1.10	0.95	0.91	1.44	1.41	0.70	0.71
	Full	0.67	0.73	1.50	1.37	1.06	1.12	0.94	0.89	1.50	1.49	0.67	0.67
4 H.P. Cushman ^b	Half	1.00	1.00	1.00	1.00	1.00	0.97	1.00	1.03	1.69	1.54	0.59	0.65
	Full	1.00	1.00	1.00	1.00	1.18	1.14	0.85	0.88	1.88	1.70	0.53	0.59
6 H.P. International	Half	0.89	0.96	1.12	1.04	0.94	0.99	1.07	1.01	1.14	1.12	0.87	0.89
	Full	0.71	0.77	1.42	1.30	0.85	0.90	1.18	1.11	1.07	1.05	0.94	0.95

^a Relative cost means factor by which the cost of kerosene must be multiplied to find the price that may be paid for other fuels to give the same power cost.

^b Gasoline is made the basis of computation because the engine is designed to run on gasoline.

COMPARATIVE FEEDING VALUE OF COARSE AND STANDARD RICE BRAN FOR GROWING PIGS¹

ROBERTO H. TIROL

Among the feedstuffs commonly available in many parts of the Islands is rice bran. There are in the market, however, different kinds of rice bran whose feeding value may not be the same. One kind is the standard or fine rice bran which comes from the large rice mills called the "Cono" mills. This standard rice bran consists of the cuticle of the rice kernel, the germ and a small amount of hull not separated in the milling process. The other kind is the coarse rice bran coming from the small rice mills called "Kiskisan" by the Tagalogs. This coarse rice bran consists of the hull, bran, polish as well as small particles of broken grain.

While the feeding value of the standard rice bran has been, to some degree, determined by feeding tests, no study has yet been made on the feeding value of the coarse rice bran. Considering that coarse rice bran is fed to pigs in many parts of the Islands it seemed advisable that a study be made on its feeding value, especially as more of this kind of rice bran is being used owing to the increase in use of the small rice mills.

The object of the experiment reported in this paper was to determine the comparative feeding value of coarse rice bran and standard rice bran.

REVIEW OF LITERATURE

Allas (1924) in his experiment on comparing rice bran, corn, and copra meal as supplements to sweet potato vines for growing pigs found that rice bran gave the best result as a concentrate supplement to sweet potato vines. He found that corn alone is not a good supplement. The rice bran and corn mixture, although better than corn alone, did not give as good returns as the rice bran alone.

Williams and McConnel (1922) in their study on rice bran for fattening hogs found that rice bran fed alone with tankage was not

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satisfactory, since it was unpalatable, too bulky, and produced the poorest gains. With corn chops and tankage, however, fairly good results were obtained.

Hughes and Mead (1922) studying rice and rice by-products as feed for fattening swine concluded that feeding whole rough rice with tankage is a practice of doubtful value. On the other hand, the feeding of rice by-products in combination with tankage and barley produces good market hogs economically.

Templeton and Clayton (1924) in their feeding experiments with swine at the Mississippi Experiment Station found that seventy-pound pigs fed on rations of rice polish and tankage with rye pasture, and rice bran and tankage, also with rye pasture, for 8 weeks did not do well and were unthrifty, indicating that these rations are not suitable for pigs of this size.

Fraps (1924) in his digestion experiments gave the composition of rice bran and rice polish as follows:

FEED	WATER	PROTEIN	CRUDE FIBER	ETHER EXTRACT	NITROGEN FREE EXTRACT	ASH
	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>
Rice bran	7.60	13.21	15.91	13.86	37.64	11.78
Rice polish	8.66	13.42	2.73	9.42	59.92	5.85

The coefficients of digestibility as found by him are as follows:

FEED	PROTEIN	ETHER EXTRACT	CRUDE FIBER	NITROGEN FREE EXTRACT	PRODUCTIVE VALUE
	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>
Rice bran	72.20	89.04	32.31	68.32	65.65
Rice polish	75.00	88.21	8.20	94.32	92.24

Fraps (1904) studying the composition of rice by-products summarized his findings as follows: Rice hulls have a low feeding value; their composition approximates that of wheat straw but with less value. Rice polish has a slightly higher feeding value than corn; it is about equal to oats or wheat.

According to this authority, there are three classes of rice bran as sold in Texas: (a) pure rice bran, consisting of the cuticle of the grain mixed with a small amount of hulls incidental to the process of milling; (b) rice bran mixed with rice hulls; and (c) rice bran mixed with rice polish and rice hulls. Commercial rice bran may contain as low as 4 per cent protein and as high as 50 per cent crude fiber.

Pure rice bran should contain not less than 10 per cent protein and 6 per cent fat, nor more than 20 per cent crude fiber. Pure rice bran is slightly superior in composition to corn meal. Any addition of rice hulls lowers the feeding value of the mixture.

The mixture of bran, polish and hulls in the proportions in which they come from the grain contains about 7.5 per cent protein and 28 per cent crude fiber and has a little over half the value of pure bran.

Fraps (1916) in his studies on the composition of rice and its by-products found that huller bran, or rice bran removed by the huller, is rich in protein and fat and is practically free from hulls. Rice hulls have a very low feeding value, but there is no evidence that they are actually poisonous or injurious to animals. The production coefficients of rice by-products vary with the grade as does the productive value and the digestible protein. Dust from rough rice contains much dirt and hulls and its presence in a feed is highly objectionable. Rice hull ash consists mostly of silica and has only an average fertilizer valuation of \$1.38 per ton.

According to Fraps, the Texas Feed Control Service defines rice bran as follows:

Rice bran is the cuticle of the rice grain with only such quantity of hulls as is unavoidable in the regular milling of rice. It must contain not less than 11 per cent protein, 10 per cent fat, and not more than 15 per cent crude fiber.

The quantity of hulls in rice bran may be estimated from the quantity of crude fiber present. This estimate may be based upon the average composition of rice hulls.

The percentage of hulls may be calculated by the formula:

$$X = \frac{F - R}{H - R} \quad \text{Where } X = \text{per cent of hulls}$$

F = per cent fiber in the bran

R = per cent fiber in the huller bran

H = per cent fiber in the hulls

Assuming that the average fiber in huller bran to be 8 per cent and that of hulls to be 39 per cent the formula becomes $X = \frac{F - 8}{39 - 8} = \frac{F - 8}{31}$

The quantity of hulls present for various grades would then be approximately:

<i>Crude fiber per cent</i>	<i>Hull per cent</i>
8	0
10	6.4
12	12.9
15	22.6

The feeding value of rice bran and rice polish depends upon, (a) the quantity of digestible protein; (b) the productive value; and (c) the suitability to animals.

Since the values of rice bran and rice hulls are different, the proportion of hulls in rice bran, which can be judged by the crude fiber content, affects the production coefficients. The following productive coefficients of rice by-products are given by Fraps:

Productive coefficients of rice by-products

	PROTEIN	FREE EXTRACT	CRUDE FIBER	NITROGEN ETHER EXTRACT	COEFFICIENT OF DIGESTIBILITY OF PROTEIN
Rice bran, 8 per cent (8-9), 0 hulls .....	.155	.540	.023	.217	.663
Rice bran, 10 per cent (9-11), 6.4 hulls .....	.153	.539	0	.211	.654
Rice bran, 12 per cent (11-13), 12.9 hulls ...	.151	.538	.016	.205	.644
Rice bran, 15 per cent (13-16.5) 22.6 hulls ..	.147	.536	.032	.196	.626
Rice bran, 19 per cent (16.5-19) 32.3 hulls ..	.142	.533	.042	.185	.604
Rice bran, 20 per cent .....	.138	.530	.048	.178	.508
Hulls .....	.024	.318	.070	.087	.10
Polish .....	.158	.490	.010	.227	.673

Fraps (1916) stated that "rice hulls have a productive value of approximately 3.2 pounds per hundred. That is to say, 100 pounds ground rice hulls will produce 3.2 pounds fat on an animal already receiving enough feed for maintenance".

Warren, (1923) in his experiments on rice bran and rice polish for growing and fattening hogs found that during the milling process, rough rice yields about 10 per cent of rice bran and 3 per cent of rice polish.

TIME AND PLACE OF THE WORK

This work was conducted in the Department of Animal Husbandry, College of Agriculture, Los Baños. The experiment was begun August 4, 1930 and closed on March 1, 1931, thus covering a period of 210 days. The experiment was divided into three 70-day periods. The first period was a feeding test for 60-day old pigs; the second period for 130-day old pigs; and the third period for 200-day old pigs.

MATERIALS AND METHODS

Animals used

Eighteen Berkjala weanlings, nine castrated males and nine females, were used in this experiment. The pigs were fairly uniform in conformation, condition, and age. They were divided into three lots which were as uniform as possible as to weight, condition and sex.

Feeds used

The feeds used were ground corn, coarse rice bran, standard rice bran, copra meal, and dried shrimps. The proportions by weight of the feeds used in the ration of each of the different lots were as follows:

FEEDS	LOT I	LOT II	LOT III
Corn	20 parts	20 parts	20 parts
Rice bran (fine)	60 "	0 "	30 "
Rice bran (coarse)	0 "	60 "	30 "
Copra meal	15 "	15 "	15 "
Shrimps	5 "	5 "	5 "

The analysis of the two kinds of rice bran used in this experiment is as follows:

Showing the analysis of standard rice bran and coarse rice bran^a

FEED	MOISTURE	FATS OR ETHER EXTRACT	ASH	PROTEIN N 6.25	CRUDE FIBER	CARBO- HYDRATES N.F.E.	CALORIES PER 100 GRAMS
Standard rice bran	10.64	5.82	14.17	10.35	12.73	46.29	286.35
Coarse rice bran	10.48	1.11	15.03	4.25	24.48	44.65	210.81

^a Analyzed in the Department of Agricultural Chemistry.

To every 100 kilograms of grain mixture given in the tabulation, two kilograms of the following mineral mixture were added:

Common salt (NaCl)	0.95 kgm.
Ground corn-cob charcoal	0.95 "
Lime (CaO)	0.10 "
Total	2.00 kgm.

Method used

Allotment of pigs. There were three lots of six pigs each in this experiment. Lot I, as the control, was given the mixture containing the fine rice bran; lot II was given the same ration mixture except that coarse rice bran was used instead of the fine rice bran, and lot III received a similar ration except that only one-half of the amount of fine rice bran used in lot I and one-half of the same amount of coarse rice bran used in lot II were used.

Duration of experiment. The work was carried for 210 days divided into three 70-day periods, each of which may be considered a complete experiment in itself. No re-allotment of pigs was made as the experiment passed on from one period to another.

Weighing. Each pig was weighed on three consecutive days and the average was taken as the initial weight. The final weight was taken in like manner. During the whole course of the experiment, individual weekly weights were taken in the afternoon just before the pigs were given their evening meal.

CARE AND MANAGEMENT

Feeding

The pigs were hand-fed twice daily, at 5:00 to 6:00 a. m. and 5:00 to 6:00 p. m. They were given as much feed as they would readily consume.

Handling of the pigs between meals

During the first period, all the pigs after each feeding were driven into one of the one-fourth hectare grass pastures. At noon they were driven to the hog house to wallow and to drink. They were then driven back to the pasture. After feeding in the afternoon, the pigs were placed in the hog house for the night.

On October 1, 1930, when experiment II was begun, the pigs were turned into a good pasture of mungo. They remained in this pasture until about the end of the month. From November to the end of the study they were turned again on grass pasture. The pigs in each lot were trained to enter their respective pens at feeding time. Except for the difference in the three rations the animals received the same treatment throughout the whole period of the experiment.

Observations

First 70-day period. Lot I pigs (standard rice bran) consumed the most feed and in the shortest time. They made the fastest gain. They were healthy and in fine condition throughout the experiment.

Lot II pigs (coarse rice bran) consumed the least feed and took the longest time. They did not appear to relish their feed. Some of the pigs gradually lost weight and with all of them the hair began to be rough.

Lot III pigs (standard and coarse rice bran) were second in respect to the amount of feed they consumed and the length of time it took them to eat their meals. Their appetite was only a little better than lot II. Throughout the period they were intermediate in condition between lots I and II.

Second 70-day period. Lot I took the shortest time to eat their meals and consumed the most feed. The animals in this lot were in excellent health throughout the whole period and had a fine glossy coat of hair.

Lot II continued to take the longest time to eat their meals. They were thin and their coats were rough. Most of them were in poor health and appeared listless.

Lot III was second in the amount of feed consumed and in the time it took them to finish their meals. The animals were in medium health but their coat of hair became coarse. They developed a better appetite than in the first period and made fairly rapid gains in weight.

Third 70-day period. Lot I continued to have the best appetite. The pigs continued to make the most rapid gains in weight. Throughout the whole period the animals were in excellent health and condition. All of them had a sleek and fine appearance at the close of the experiment.

Lot II consumed the least feed and took the longest time. The animals had very poor appetites. With the exception of two animals, all were extremely thin, scrawny and pot-bellied with long rough hair and listless eyes. Animal F 1090 died on December 25, 1930 from kidney worms and general debility. On January 14, 1931, animal Bb 1096 died of chronic inflammation of the stomach and emaciation. On February 3, 1931, animal F 1082 died of kidney worms. For three days before it died, it refused to eat. On February 7, 1931, animal Bb 1098, died of kidney worms and general weakness. At the end of the experiment only two animals remained alive and these had rough coats and were ragged in appearance.

Lot III was second in the amount of feed consumed and the time it took them to finish their meals. The animals ate their feed heartily and made fairly rapid gains in weight. On February 18, 1931, pig 1097 became lame. This condition was observed in the other pigs but less pronounced. After a few days, however, the pigs recovered from this affliction. At the close of the experiment the animals were healthy and moderately fat, but rough in appearance.

DISCUSSION OF RESULTS

Summary of results

	LOT I	LOT II	LOT III
<i>First 70-day period</i>			
Average daily gain in weight	0.15 kgm.	0.04 kgm.	0.05 kgm.
Feed consumed per kgm. gain	3.44 "	6.92 "	7.83 "
Feed cost per kgm. gain	P0.20	P0.28	P0.38
<i>Second 70-day period</i>			
Average daily gain in weight	0.28 kgm.	0.08 kgm.	0.18 kgm.
Feed consumed per kgm. gain	3.97 "	7.20 "	4.72 "
Feed cost per kgm. gain	P0.22	P0.30	P0.23
<i>Third 70-day period</i>			
Average daily gain in weight	0.33 kgm.	0.04 kgm.	0.17 kgm.
Feed consumed per kgm. gain	5.22 "	24.76 "	8.14 "
Feed cost per kgm. gain	P0.28	P0.90	P0.37
<i>Combined 210-day period</i>			
Average daily gain in weight	0.25 kgm.	0.06 kgm.	0.14 kgm.
Feed consumed per kgm. gain	4.41 "	11.50 "	6.57 "
Feed cost per kgm. gain	P0.24	P0.46	P0.31

First 70-day period. It may be seen in the "Summary of Results" that in rate of making gain lot II with coarse rice bran in the ration was only 27 per cent as efficient as lot I, the best of all the lots. Lot III compared with lot I was 38 per cent as efficient.

The principal reason for lot II giving the poorest results was that the pigs found their feed unpalatable and so consumed very little of it. In lot III, however, where there was an equal part of fine rice bran to every part of the coarse rice bran present in the ration, the pigs consumed more feed than did those of lot II.

From the standpoint of feed needed to make a given unit of gain, it is obvious that lot II was only 50 per cent and lot III, 44 per cent as efficient as lot I. In other words, lot III in this regard was actually poorer than lot II. It appears that to form the ration of lot III, the substitution of an equal amount of fine rice bran for half of the amount of coarse rice bran used in lot II was an improvement, but only to the extent of improving the palatability of the ration. For lot III pigs were able to consume a ration of 40 per cent more than the pigs in lot II were able to take and consequently they made more rapid gains. The good effect, however, was not sufficiently marked to overcome the ill effects of feeding coarse rice bran to young growing pigs.

Although coarse rice bran costs only half as much as fine rice bran, yet its effect upon the gain in weight of the pigs was such that there was a marked difference between the cost of the gains made by the lots. In lot I it took ₱0.20 worth of feed to make a kilogram gain; in lot II, ₱0.28; and in lot III, ₱0.38.

Second 70-day period. In this second period (see "Summary of Results") the fine rice bran remained the best, with lot III very much better than lot II. It is interesting to note that during this period the cost of feed per kilogram gain made by the pigs in lot III was about the same as in lot I. This brings out the fact that the unsuitability of coarse rice bran for feeding purposes became less marked as the pigs grew older, provided, of course, that they were given a sufficient amount of the other feeds to make the ration fairly balanced.

Third 70-day period. (See "Summary of Results.") The fine rice bran lot made the most rapid gain, keeping the lead from the first period till the end of the experiment. Lot II, on the other hand, made no improvement at all.

It is important to note that while the pigs in lot I remained healthy and in good condition till the end of the experiment, the pigs in lot II were all very thin and sickly looking. Four of these died during this period from kidney worm infection and general debility. One died of chronic inflammation of the stomach. There is no doubt that the primary cause of death was insufficient nourishment. This agrees with the findings of Boncato (1932) in his study on the efficiency of the different methods for controlling stomach and intestinal worms in sheep and goats. He arrived at the conclusion that good feeding is a better measure in promoting good health and in reducing parasitic infestation of the animals than feeding them poorly and treating them with copper sulfate or copper-sulfate-nicotine solution.

The pigs in lot III, although moderately healthy, had the rough coats and ragged appearance of the pigs in lot II.

The three periods combined. The outstanding result obtained in combining the partial results obtained from the three partial periods is that the fine rice bran lot made the most rapid gain in weight, the fine and coarse rice bran lot, second, and the coarse rice bran, the poorest. Lot I made an average daily gain of 0.25 kilogram; lot II, 0.06 kilogram; and lot III, 0.13 kilogram.

In the amount of feed required to make a kilogram of gain, lot I required 4.41 kilograms; lot II, 11.50 kilograms; and lot III, 6.57 kilograms.

From the standpoint of economy of gain, the fine rice bran lot was always the first, the coarse and fine rice bran, second, and the coarse rice bran lot the last. Thus, the feed cost per kilogram of gain in weight in lot I was ₱0.24; in lot II was ₱0.46; and in lot III, ₱0.31.

Estimating, however, from the economic point of view, that is, according to the saleable gain in weight at the end of the 210-day period, lot II was a losing proposition. The total final weight of lot II was 71 kilograms and the total initial weight was 52.90 kilograms, leaving a total gain of 18.10 kilograms during the feeding period of 210 days. To make this gain the lot consumed 602.2 kilograms of feed. Thus, the lot required the consumption of 33.27 kilograms of feed worth ₱1.31 to make a kilogram of gain.

One of the most important and interesting results, which became more evident as the experiment progressed, was the appearance of the pigs in the three lots. While the pigs in the fine rice bran lot were uniformly healthy and sleek looking with a fine coat, the pigs in the coarse rice bran lot were ailing practically all the time; were scrawny and had rough coats.

CONCLUSIONS

1. Assuming the feeding value of the ration containing fine rice bran to be 100 per cent, then the ration containing rough rice bran was found to be only 38 per cent in feeding value, and the ration containing coarse and standard rice bran in equal proportions was found to be 67 per cent.

2. Assuming the feed cost per kilogram gain of the ration containing fine rice bran to be 100 per cent, then the ration containing rough rice bran was found to cost 92 per cent more than the fine rice bran, and the ration containing rough and fine rice bran in equal proportions was found to cost 29 per cent more than the fine rice bran.

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ABSTRACT¹

A study of *Saccharum spontaneum* Linn. Subsp. *Indicum* Hack from the plant breeding standpoint. SIMON L. PEREZ. (*Thesis presented for graduation, 1930, from the College of Agriculture No. 344; Experiment Station contribution No. 859.*)—The object of this experiment was to study the only two available species of talahib, *Saccharum spontaneum*, from the plant breeding standpoint with emphasis on the flowering habit and flower characteristics. For lack of names, these two species were arbitrarily designated as Large talahib and Small talahib.

Two kinds of planting materials were used—rootstocks and stem cuttings. Similar cultures of C.A.C. 87 and S-1861 were also started for observation and comparison. All the cultures were given the same treatment.

The Small talahib flowered at the age of 152 days; the Large talahib at 181 days; the variety C.A.C. 87 at 284 days; and the S-1861 at 289 days. The flowers of the Small talahib began to open as early as 8:00 p.m. The average length of time from opening to dehiscence was 34 minutes. The flowers of the variety S-1861 began to open as early as 10:00 p.m. and as late as 5:15 a.m.; the average length of time from opening to dehiscence was 38 minutes.

The percentage of flowering of the Small talahib was 80; C.A.C. 87, 97 in seed boxes and S-1861, 69. The opening of the flowers of all the varieties studied was continuous day and night. The Small talahib had an average of 14.60 matured stalks per stool; Large talahib, 33.80 stalks; C.A.C. 87, 11.25 stalks; and S-1861, 11.86 stalks. The points of the Small talahib had a zero per cent of germination in the field in the dry season, and the rootstocks of the Large talahib had a 100 per cent germination in seed boxes. In the field, the points of C.A.C. 87 had 35 per cent germination and those of S-1861 had 13 per cent. In general, the seeds of the varieties studied germinated in 3 1/2 days after sowing. The average number of tillers of the Small talahib seedlings (26 weeks old) at transplanting time was 3.5. The average percentages of germination of pollen grains were as follows: Small talahib, 15.11; C.A.C. 87, 14.98; and S-1861, 9.55. The

¹ Abstract prepared as a part of the required work in English 3a, College of Agriculture.

marcotted stalks of both the Small and the Large talahib had an abundance of roots after 21 days; that of C.A.C. 87, after 27 days; and that of S-1861, after 25 days.

The small talahib had 537 fertile pollen grains per anther, 1,611 per flower, and 3,368,601 per arrow; C. A. C. 87 had 1,530 pollen grains per anther, 1,989 per flower, and 13,403,926 per arrow. The average number of flowers per arrow of the Small talahib was 2,091; that of the C. A. C. 87 was 28,362; and that of S-1861 was 6,734. The average number of pollen grains in an anther of the Small talahib was 832, in one flower, 2,496, and in one arrow, 5,199,136; that of C. A. C. 87, 2,779 per anther, 8,337 per flower, and 236,453,994 per arrow; and that of S-1861 in an anther was 800, in one flower, 2,400, and in an arrow, 5,387,200.

The rootstocks of both the Large and the Small talahibs had higher Brix polarization and higher purity than their stalks.

—*Abstract by Sabas P. Tangco*

CURRENT NOTES

The Arabs of the Sahara reckon their flocks of sheep their most valuable property. They drink the ewes' milk regularly. Like the Syrian sheep, the Arab sheep are very prolific, generally lambing in spring and again in autumn. These two breeds are probably closely allied one to the other.

Captain Burnaby, in his book "A Ride to Khiva," says that "sheep make up the entire riches of the nomad tribes. A Kirghiz lives upon their milk during the summer and autumn."

Ewes fill the place of sows in Iceland, as many as 1,000 being kept by large farmers. They run on the hills during the summer, and are housed during the long winter.

Mare's milk plays a large part in the diet of Asiatic peoples, who rear large numbers of horses. Marco Polo, the Italian traveller of the thirteenth century, has recorded of the great Asiatic prince, Kublai Khan, that he kept over 10,000 pure white horses and mares, the milk of the latter being reserved for the Khan and his household, and the members of one great tribe who enjoyed the privilege of drinking it as a reward for military services rendered.

Asses' milk has been used from a remote period for human consumption. It was esteemed by the ancient Romans, and there is a certain demand for it in London at the present day for invalids' use.

Among other domestic animals used for milking purposes are the buffalo, employed for draught and plough in various parts of Asia and in some parts of South-Eastern Europe; the yak, used as a beast of burden in Tibet, whose milk is very similar to that of the cow, and is used also to make butter and cheese; the camel in Egypt and many parts of Asia; and in the Arctic regions of Europe and Asia the reindeer, upon which the Samoyedes and other nomadic tribes are dependent for their existence.

—*Queensland Agricultural Journal*, September, 1932

The total loss caused by the decrease in rice production and low prices in the market in 1931 was close to ₱56,000,000 while the damages to crops in general from pests and disease amounted to some ₱20,000,000.

Commerce and Industry Journal, (Philippines) April, 1932.

With an ordinary bent-wire paper clip together with a pin and a pencil, you can draw circles accurately as with a compass in those emergencies when there is no compass at hand. Drive the pin into the paper far enough to hold firmly, and use it as a center. You can then swing in two sizes of circles without bending the clip; and by straightening it out to various degrees, you can produce any number of circles up to a diameter of about 4-3/4 in., provided the clip is of the fairly large size which is now commonly regarded as standard and not one of the smaller sizes. Of course, if a "giant" size clip is used, large circles can be drawn.—R. E.

Popular Science Monthly, July, 1932.

Over 3,100,000,000 eggs were imported into Britain last year. The volume of Empire supplies was the largest ever recorded, and accounted for 24 per cent of the total imports. Denmark is the chief source of imports, sending 29 per cent of the total from all sources. Britain draws her imports of eggs from, altogether, over 30 countries.

Tasmanian Fruitgrower and Farmer, September 1, 1932.

Among the disease carriers may be included the mosquitoes, tsetse flies, Tabanids, and house-flies. Mosquitoes, in addition to

their annoying blood-sucking habits, are well known as carriers of the protozoan diseases: Malaria and Yellow Fever. Tsetse flies are the carriers of another protozoan disease in man known as *Trypanosomiasis* or sleeping sickness. Tabanids, in addition to their biting habits, are carriers of the *surra* disease in domestic animals. Germs of Typhoid, Cholera, Dysentery, Infantile diarrhoea etc., are also carried by the house fly by feeding on infected material and transferring the germs later on to human food.

The Madras Agricultural Journal July, 1931.

The avocado is comparatively new in the Philippines. There are only a few bearing trees. Perhaps the largest number in any one place is in Bukidnon, where they seem to grow almost to perfection and bear heavily. In recent years many trees have been planted in various parts of the Islands. It is safe to say that it will not be very long before the avocado will be abundant throughout the archipelago and will find a place of great importance as a food. The trees which are now bearing fruit in Bukidnon, Manila, and other localities yield bountifully. Some of the trees planted at Buco, Mountain Province, where the elevation is about 2,000 feet have been producing large yields. This wide range of successful growth predicts a very bright future for the cultivation and use of the avocado in the Philippines.

Philippine Farm Journal, September, 1932.

COLLEGE AND ALUMNI NOTES

Dr. William D. Funkhouser, dean of the graduate school of the University of Kentucky and well-known specialist in Membracidae, accompanied by Mr. R. C. McGregor, of the Bureau of Science, visited the College campus on December 6. Their special object was to examine the collection in the Department of Entomology and see a part of the Maquiling National Botanic Gardens. One of the most active co-operators of the late Dean Baker, Dean Funkhouser described many new species of Philippine Membracidae with Mount Maquiling as the type locality.

Doctor Copeland gave the last of his series of lectures on Practical Ethics on the afternoon of December 13. In appreciation of these most interesting and valuable lectures the faculty gave a dinner to Doctor and Mrs. Copeland at Molawin Hall in the evening of December 13.

Mr. Fred C. Hadden, entomologist with the Hawaii Sugar Association who was a Campus resident for about two years and a half sailed for Honolulu on November 5. Mr. Hadden's special work for the association was studying and breeding and shipping parasites on the Japanese beetle and the pink mealy bug. Mr. Hadden made a fine personal collection of beetles while here. He also became an orchid fancier. The College community regrets his departure.

Mr. Vicente de la Cruz, Governor of Leyte and Mr. and Mrs. Rafael Martinez were Campus visitors on November 15. Mr. Martinez owns ranches on the islands of Leyte and Masbate. He wished to look over the College as he is planning to send his son here for special work in cattle management.

The fourth travelogue of the series under the auspices of the Christian Social Center was given by Dr. N. B. Mendiola on Java with special attention to agriculture on the large estates. Many photographs projected on the screen added to the interest of the talk.

In the fifth travelogue Mr. E. M. Bautista of the Department of Engineering, the audience were taken as workers through a season in a salmon canning factory in Alaska. As Mr. Bautista spoke from actual experience it was a truly realistic experience.

Basunie Saropie, a senior student gave two Sumatran dances after the talk. Both were interpretative, and the one in which he carried lighted candles was of wierd beauty. Mr. Saropie had consented to give these dances in connection with the Java evening but was absent on a class trip.

On the evening of December 2 under the auspices of the Christian Endeavor Society a concert was given at Center. The proceeds will be used in providing books and magazines and a bookcase on wheels—something like a tea wagon—for the College Infirmary.

The musical part of the program was given by Mr. and Mrs. E. M. Cooper and their daughter Carol of the Army and Navy Y.M.C.A. and a "Y" quartet. It is difficult to say which gave the most pleasure, the delightful numbers by the Cooper family or the Negro Spirituals by the quartet. As Negro Spirituals are a new form of song on the Campus the students were very enthusiastic and the singing by the quartet richly merited it. The Vio, a new one string instrument was interesting—and "Largo" by Handel played upon it by Mrs. Cooper was surprisingly pleasing.

Miss Laura Mae Williamson, instructor in English in the Rural High School, read "The Granter of Wishes", a play with a prologue, scene, and an epilogue. Every line of this "nutshell" play fairly sparkles. One chortles and is pleasantly stimulated. And Miss Williamson gave one hundred per cent value to every phrase, and gave it with artistic charm. The garden created by Mr. Bousman gave a satisfying setting.

The seventy-eighth meeting of the Los Baños Biological Club was held on November 17, 1932, at 7:30 p. m. in the Poultry Husbandry lecture room of the College of Agriculture, Los Baños, Laguna.

The following papers were read and discussed.

1. "Artificial Coloring of Citrus Fruits."

By Dr. Leon G. Gonzalez.

2. "The Resistance of the Eggs and Larvae of Swine Kidney Worm, *Stephanurus dentatus* Diesing."

By Dr. Z. de Jesus.

On the evening of December 14, Vassily Prihodko 'cellist and Jena von Takacs, pianist, of the faculty of the Conservatory of Music, University of the Philippines, gave a recital at Center.

The audience were given an evening of enjoyment by the following program presented with fine musicianship by these talented artists:

I

Sonata A—major No. 3 for piano and 'cello L. van Beethoven (177-1827)

a. Allegro, ma non tanto

b. Scherzo, (Allegro Molto)

c. Adagio cantabile, Allegro vivace

Prof. J. von Takacs and Prof. V. Prihodko

II

I. a. Prelude C sharp minor

F. Chopin (1809-1849)

b. Valse C sharp minor

c. Military-Polonaise

II. Hungarian Rhapsodie No. 13

F. Liszt (1811-1886)

Prof. J. von Takacs

III

I. a. Melodie

Ch. Gluck (1714-1787)

b. Rondo

L. Boccherini (1743-1895)

II. a. Playera

E. Granados

b. Orientale

A. Arensky

III. Fantasie Characteristique

F. Servais

Prof. V. Prihodko

The Committee on awarding the Baker Memorial Scholarship for 1932-1933 divided the award between Filomeno Butac and Proceso Alcala. The rules of the scholarship stipulate that the student must be wholly or partly self-supporting and the award is made "on the basis of character, promise of future usefulness and scholarship." The scholarship record at the time of the award of Filomeno Butac was 2.72; of Proceso Alcala, 2.49. Neither one has ever been posted for scholarship records below passing.

Thanksgiving morning the Senior class planted their Class Tree (*Amherisia nobilis*). The tree is planted near the pavilion (the gift of the classes '31 and '32—but still unnamed.) That this is the first Class Tree to be planted on this Campus made the occasion specially memorable.

College and class songs were sung with proper spirit and yells were shouted vigorously under the leadership of Antonio Flores. Mariano Pamintuan spoke on "Senior Day", followed by Class President Theodore Schuck who told about the tree. As the class listened to the words of wisdom spoken by the Class Adviser Dr. Miguel Manresa and Dean Gonzalez they, the "hungry sheep" were not left "unfed." Mrs. Leon Gonzalez sponsored the ceremony of planting the tree. A box that *anay* cannot devour nor moisture destroy in which a personal prophecy by each member of the class was deposited was buried near the roots of the tree. The Class will gather around this tree in 1947, unearth the box, open it and compare the prophecies with the achievements. The planting ceremony was followed by an apostrophe to the Tree by Professor Emma S. Yule. Dean Gonzalez administered the Senior pledge. Spasmodic dashes and showers of rain in no way dampened the ardor of the Seniors in this the first Class Tree planting.

In the evening this enterprising Class of '33 "put on" a fine Torch Parade.

The second presentation on the evening of November 23 of *The Mikado* by the "Mimics" was equally as successful as the first presentation on the evening of Loyalty Day. New "stars" appeared in most of the principal parts.

Cast of Characters

The Mikado	Flaviano Olivares
Nanki Poo	Sabas Tangco
Ko ko	Onofre Casupang
Pooh Bah	Raul de Arana
Pish Tush	Felix de Leon Flores
Katisha	Mamerta Manahan Ilagan
Yum Yum	Virgina Mondoñedo
Pitti Sing	Leona Atienza
Peep Bo	Andrea Balbin

Chorus

- First tenors:** Numeriano Cuevas; Gusaino Ybañez; Melanio Rana; Laureano Lucas; Lee Yadao; Francisco Gomez.
- Second tenors:** Amado Balingao; Dominador Batenga; Abel Silva; Venancio Duarte; José Quintos; Romulo Gines; Federico Paguyo; Felix Remigio; Andres Caranto.
- First basses:** Rocino Base; Primo Castro; Guillermo Fran; Miguel Guzman; Rasuman Macalandong; Ladislao Martir; Inocencio Perez; Federico Reyes; Basunie Saropie; Celestino Quilang.
- Second Basses:** Pedro Lorenzo; Santos Belo; Constantin Valera; Victorio Antonio.

The addition of more voices and additional practice made the chorus almost professional in execution, both in singing and acting. The director, Miss Anne Cole, Assistant Professor of English, merits warm praise for the success of this Mimics presentation. And to Mrs. Hugh Bousman, for her exceptional work in training the singing, both solos and chorus, the highest praise is due. The Mimics, the Department of English, indeed, the whole College are profoundly grateful to her for so freely giving of her valuable services in presenting this opera.

On the evening of December 4, Miss Cole took the whole cast to Manila and from the KZRM Studio broadcast the greater part of the opera. This, the first broadcasting by students of the University of the Philippines was most successful. Every "tuner in" on the Campus was highly elated and quite chesty with pride in "Our Mimics". And, doubtless, in the home towns throughout the Islands many parents and friends had similar feelings as they heard for the first time the voice of "their boy or girl" come over the air. Again, Mrs. Bousman with her artistic accompaniment deserved and has received plaudits.

This broadcasting is a real event in the history of the College. The names of Miss Cole, Mrs. Bousman and The Mimics, may in the future, if historical truth is valued, be written in red letters, possibly placed on bronze tablets in the history of University broadcasting in the Philippines.

On the evening of November 30, the story of the Prodigal Son—dramatized by Miss Katherine Turner of the Department of English—was most effectively and artistically presented by the Church Dramatic Guild at Center under the direction of Mr. and Mrs. Hugh Bousman.

In the evening of December 5, Mothers Day was observed in the Protestant chapel with a simple impressive service.

The Secretary of the College of Agriculture reports as follows on registration for the second semester.

Total registration, 1st semester, 1932-33 excluding cross-registration from the College of Veterinary Science, School of Forestry and U.P. Rural High School	621
Total registration, 2nd semester, 1932-33 excluding cross-registration from the College of Veterinary Science, School of Forestry and U.P. Rural High School	566
Less new registrants, 2nd semester, 1932-33	23
Exclusive College of Agriculture 2nd semester registration of 1st semester registrants	543
Students withdrawing during the 1st semester	78

The Associated Women Students gave a delightful tea in the Club Room in Molawin Hall on December 14. It was a "hen" affair. For entertainment and mental sustenance Professor Emma S. Yule on invitation of the Association gave an informal talk on Japanese women and showed the girls some articles connected with Japanese life. Misses Balbin and Torres sang a duet and Miss Atienza, a solo.

Under the initiation of Miss Turner, adviser of the Associated Women Students and of the Aggie Pen Club and with the cordial assistance of Dr. F. O. Santos, Manager of Molawin Hall, a room has been fitted up as a club meeting place for the organizations sponsored by the English department. These three organizations, the Mimics, A. W. S. and Aggie Pen Club, named in sequence of organization all joined in bearing the expense of the window seats, book shelves, screens and curtains and cushions and the last two clubs shared in

the manual work of putting them in. The Mimics at the time this was done were busy with Mikado rehearsals. A cosy well-lighted room is the result.

This year's sugar technology seniors are now out on Sugar Mill Practice B in the following centrals; Virgilio Bustus at Central Azucarrera de Tarlac; Criscenciano Causing at La Carlota; Newton Jison at Bacolod-Murcia; Jesus Montemayor at La Carlota; Domingo Regner at La Carlota; Rafael Rotor at The Pampanga Sugar Development Co.; Jose Sto. Domingo at La Carlota; Conrado Veloso at Talisay-Cebu Sugar Company.

Mr. Agapito Muyargas '32 B.S.Agr. now employed as agriculturist with the Red Cross visited the Campus November 14. While distributing planting material in the parts of Jolo devastated by the typhoon of some months ago Mr. Muyargas went to Sandakan, British North Borneo. Here he met Messrs. Feliciano Calacula '31 and Juvenio Leaña '25 and heard good reports of Messrs. Silvino Hernandez '29 and Glicerio Caguicla '31 who are also employed by the British North Borneo Company.

The Department of Animal Husbandry recently completed the construction of a dipping vat for cattle and other large animals at a cost of approximately P500.

Mr. Antonio Guanzon, '30, visited the College on November 15 and renewed old friendships. He is at present engaged in sugar planting at Murcia, and fishing at Cadiz, Negros Occidental.

Mr. Nicomedes Flores '27 is principal of Aborlan Agricultural School in Palawan. Messrs. Sebastian Fabello '29 and Joe R. Haynes '30 are on the teaching staff.

Vicente T. Florida, '27, has been engaged by Dr. Virgilio Gonzalez to supervise his sugar cane plantation in Bogo, Cebu. As a part of his work, Mr. Florida is conducting experiments to determine the varieties best adapted to the locality and the amount of fertilizer needed for optimum growth of sugar cane.

Pacifico L. Masibay, '25, is engaged in farming in Zaragoza, Nueva Ecija.

Gonzalo Salazar, '25, is chemist-secretary-treasurer of the San Carlos Sugar Planters' Association.

Fermin J. Gamboa, '22, is managing the farm of Mr. Vicente Lopez at Vallehermoso, Negros Oriental. He is now actively engaged in locust extermination.

Salustiano Gonzalez, '25, of the Bureau of Plant Industry, is in charge of the locust campaign in San Carlos district, Negros Occidental.

Domingo J. Cayabyab, '29, is a rural credit agent in Cagayan, Oriental Misamis.

CONCERNING MANURE

After Liebig had announced his famous theory of manuring in the middle of the nineteenth century, farmers in England generally believed that the low productivity of an infertile soil was solely due to the lack of some particular mineral element which could easily be supplied from an external source. It was the custom of agricultural chemists in those days to attempt to construct exact "balance sheets" based on bulk chemical analyses of soils and crops, and to prescribe from the deficit side of the balance sheet suitable manurial materials that would correct the soil's infertility. Although the procedure seemed convincing enough, actual experience and many failures showed that the inter-relation between soils and crops was not so simple as Liebig had supposed. Subsequent investigations into the role of nutrients in plant growth have slowly revealed the fact that, unless all other growth factors (such as water supply, air supply, absence of harmful agencies, including excessive acidity, or alkalinity, undesirable micro-organisms and plant toxins) are exerting their greatest effects, the mere addition of mineral manures may fail to produce good growth and better crops.

Many manurial treatments, prescribed even at the present day, take no account of the operation of factors other than the direct nutritional factor. Thus, the oft-discussed question of the relative value of organic manures (such as farmyard manure and green dressings) as opposed to artificial inorganic materials is frequently considered in terms of the amounts of "plant-food" that each may contribute to a soil, whereas actually an apparent superiority of one over the other may be due mainly to its favourable effect on soil tilth, water supply, aëration, or some other soil property.

During the prosecution of manurial experiments, attempts ought therefore to be made to disentangle the various factors that contribute towards success of any particular treatment, so that the relative importance of each factor may be accurately assessed. Frequently the agriculturist is quite satisfied merely to measure the effect of manurial treatments on total crop yield; he is seldom interested in the *reasons* for increased or diminished returns; yet, by the application of suitable experimental methods, these reasons may sometimes quite easily be elucidated, and the knowledge thus acquired may be used in the formulation of better manurial methods. . . .

Secondly, too little attention is generally given to the inherent character, composition and physical properties of the soil itself; just as if, indeed, soil were an inert medium, constant and uniform in its behaviour, and functioning in no other way than a simple sand culture. That there are an unlimited number of kinds of soil seems often to be lost sight of altogether. Failure to appreciate this obvious fact has led to many grave mistakes in the selection of methods of manurial treatment. Manurial programmes that are specially suited, for instance, to the successful cultivation of sugar-canes in Hawaii may be entirely unsuitable when applied unmodified to the cane crop of Barbados or of Natal.

The soil is *not* an inert medium. When manures are added to it, profound chemical actions and inter-actions ensue. These may vary widely in nature and degree with different soils. Thus, the ferroginous, red laterite type of soil (such as occurs in West Africa, India, Java, Hawaii and many other humid tropical countries) is entirely different in physical and chemical behaviour from the siliceous soils developed under less humid cooler climates. Not only is lateritic soil naturally very porous and open, though retentive of moisture, but also its chemical properties are peculiar, in that the soil is capable of fixing relatively large amounts of phosphate, and perhaps even nitrate. The siliceous soils, on the other hand, fix very little phosphate and nitrate, but are capable of retaining greater amounts of potash. The growing plant absorbs only those substances that the soil can deliver in a suitable form to its roots; the nature and amount of these substances, as well as their availability, are only indirectly due to materials added as manure. It is therefore obviously inaccurate to speak of an ideal manurial mixture for a particular crop; one should speak rather of manuring a particular *soil* for a particular crop. Furthermore, not only do the total amounts of added manurial ingredients affect differently the nature and degree of interaction with the soil, but their actual proportionate amounts are also important. Recently research has stressed the significance of "balanced ratios" in soil nutrients delivered to plant roots, and has even indicated that different ratios are perhaps required at different stages in the plant's development. Thus, in the early stages, a preponderance of nitrogen and potash in most cases is required, whilst in later life, further additions of potash are less necessary. Even the nature of the other entities added along with manures such as potash seem to exert their specific influence. Thus experiments have indicated that potash supplied as muriate may produce somewhat different results from those obtained when sulphate of potash is employed.

The experimenter on manurial requirements requires to know many facts that have recently been demonstrated by the plant physiologist, if he would discover the very best way in which to produce maximum crops. There would appear to be no limit to the number of inter-related factors that must severally be experimentally examined in order to attain this object...

Tropical Agriculture, October, 1932

CAMPUS CASTES

We have royalty—The athletes. They are untouchable in their aloofness from the common herd. They are not to be condemned, it is an inheritance, the same as the young princes in ancient times who stood in line to take their father's crowns when vacated. They are accepted, envied, and above criticism. The king can do no wrong and we have our first division of our modern feudalism.

We have nobility—the activity men. They are not of royal blood but they are the controlling element. They run campus activities and are as the lords of old, the ruling class. Theirs is the power and the glory which is almost as untouchable as the athletes except that the activity men are not born to it.

We have the fashionable gentry—the well-dressed, wealthy student who has but to loll and bask in the reflected light of his father's gold. His is the part of the court retainer, a "yes" man in a sense, but still secure enough in his wealth to be haughty and arrogant, but yet subservient to his lord and master, the activity man.

After this upper stratum of campus society is named, we have but to add the long list of students, grinds, men and women working their way through, and those who do little or nothing. It is sad, but true, in our present college feudalism, that this last class named is easily likened to the serfs in medieval times, a necessary part of society and yet unheralded, their work unsung, and their individual existence as unimportant to the whole system as the life of an ancient vassal, but their existence as a body a vital part in our accepted system, collegiate feudalism.

These classes as painted are true to campus life. It is regrettable that such should be the truth. It is as hard to vault from one stratum to another as it was in ancient times; the honest, hard-working, unassuming man is pushed down, stamped out. He has his friends, but they are of his own "class." His four years of college are soon over and he passes on, never tasting the fruits of the "lord" or sharing the "king's glories."—*Michigan State News*.

What the Colleges are Doing.

EFFECT OF LIMING ON THE GROWTH OF PIGEON PEAS IN HAWAIIAN SOILS ¹

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AND

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WITH THREE TEXT FIGURES

INTRODUCTION

This study was undertaken in an effort to determine the effect of liming upon the crop productivity of some acid pineapple soils when the pigeon pea, *Cajanus cajan* (L.) Millsp. was used as an indicator crop. The characteristics of the pigeon pea and its history in the Hawaiian Islands have been reviewed recently by Krauss (1932). The possibility of using the pigeon pea as an intercycle crop in pineapple culture warrants additional information on the response of the plants to different methods of culture. The present study summarizes some of the results obtained from liming applications.

EXPERIMENTAL

The experimental area lies in a pineapple field of the Hawaiian Pineapple Company at an elevation of about 1300 feet, has a western exposure, and receives about 80 inches of rain annually. The soil has been derived from lava, and is a clay, chocolate red in color. The subsoil which is often mottled is encountered at a depth of about 10 to 12 inches. The drainage is poor, as indicated by the mottled condition of the soil, because of the very impervious nature of the subsoil and not because of a lack of gradient.

Pineapples, *Ananas comosus* (L.) Merr. had been grown on the area for a number of years preceding this experiment. The rotation usually consisted of three years in pineapples followed by one or two

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years in a cover crop. This cover crop was usually panicum grass, *Panicum barbinode* Trin. *Crotalaria striata* DC. was rather abundant as a weed in the pineapple crop.

After the pineapple plants had been "disked down" and had decomposed in the spring of 1930, four one-half acre plots were laid out, plowed to a depth of 14 inches, and given the following treatments:

<i>Plot</i>	<i>Treatment</i>
A	Harrowed
B	Received 6 tons per acre of limestone, harrowed
C	Subsoiled and harrowed
D	Received 6 tons per acre of limestone, harrowed, received 6 tons per acre limestone plus one ton coral sand in the subsoil during a subsoiling operation, harrowed

The limestone used was specially screened ground coral rock and was furnished by the Waianae Lime Co., Oahu. It had the following composition:

Chemical analysis

Iron and aluminum oxides ($\text{Fe}_2\text{O}_3 + \text{Al}_2\text{O}_3$)	1.20 per cent
Calcium oxide (CaO)	50.23 per cent
Magnesium oxide (MgO)	2.97 per cent
Carbon dioxide (CO_2)	44.42 per cent
Others by difference	1.18 per cent

Mechanical analysis

Passing 100 mesh sieve	86 per cent
Held on 100 mesh, passing 80	7 per cent
Held on 80 mesh, passing 60	5 per cent
Held on 60 mesh, passing 40	2 per cent

Chemical analyses showed that the limestone used had a neutralizing power equal to 98.53 per cent calcium carbonate.

The limestone was applied to the subsoil through a tube directly behind the subsoil standard. To facilitate its application, coral sand was added to the limestone in the ratio of one to six of limestone. The coral sand is presumed to have had the same composition as the ground coral rock. Subsoiling furrows were approximately 18" apart and criss-crossed the field forming 18" squares.

The application of the lime to the subsoil in plot D was interrupted by rains and was not completed before January, 1931. The plots were harrowed at intervals until June when pigeon peas were planted.

CHANGE IN SOIL ACIDITY CAUSED BY LIMING

The plots were sampled on December 16, 1931 to determine the changes that had occurred in pH values, replaceable hydrogen and calcium content. Each plot was divided into five sub-areas and in each sub-area five borings were made. These were composited into one surface sample and one sub-soil sample for each sub-area or five composite samples for each horizon per plot. Surface samples were taken to a depth of about 10 inches and sub-soil samples were made from 10 to 24 inches. Since plowing before liming was to a depth of 14 inches some mixture of sub-soil into surface soil and surface soil into sub-soil took place. In addition to this situation the line of demarcation between surface and sub-soil did not always occur at 10 inches. Therefore it must be understood that the analytical values obtained were for the 10-inch surface layer and the 14-inch layer lying below. Since the principal constituent of the top 10-inch layer is surface soil it has been called such for convenience.

In all calculations the weight per acre foot of cultivated surface soil was taken to be 2,400,000 pounds and that of the sub-soil as 3,000,000 pounds. Data from a thorough investigation of the volume weight of pineapple soils by Abel and Dean² in this particular field and adjoining ones are the basis for these values. The volume weight of our Hawaiian soils often lies below 1.0 and usually does not exceed 1.2.

Replaceable calcium was determined by the method of Kelly and Brown (1924) using ammonium chloride as the replacing solution. Total exchange capacity was determined by the method of Page and Williams (1925). Replaceable hydrogen was considered to be the difference between total exchange capacity and replaceable calcium. Since there are very low contents of replaceable magnesium, sodium and potassium in these soils, this method does not introduce appreciable errors. The pH values were determined by the hydrogen elec-

² F. A. E. ABEL and A. E. DEAN. Work unpublished to date.

trode method which was advocated by the committee of the International Society of Soil Science (Sigmond de, 1930). A soil water ratio of 1:2 was used. The results obtained are given in table 1.

TABLE 1

The pH values and replaceable calcium and hydrogen contents of the limed and unlimed soils

PLOT	TREATMENT	pH	REPL. H	REPL. Ca
<i>Surface</i>				
A	Plowed 14"	3.96 ± 0.03	30.52 ± 1.92	0.58 ± 0.04
B	Plowed 14" & 6 T CaCO_3	5.32 ± 0.07	20.42 ± 2.00	6.44 ± 0.58
C	Plowed 14"	4.00 ± 0.05	31.08 ± 2.84	0.78 ± 0.03
D	Plowed 14" & 6 T CaCO_3	5.69 ± 0.06	20.51 ± 1.27	6.07 ± 0.39
<i>Subsoil</i>				
A	Plowed 14"	4.03 ± 0.03	25.75 ± 0.39	0.55 ± 0.04
B	Plowed 14" & 6 T CaCO_3	4.60 ± 0.10	26.10 ± 0.46	2.64 ± 0.17
C	Plowed 14"	4.18 ± 0.06	33.66 ± 0.52	0.79 ± 0.05
D	Plowed 14" & 7 T CaCO_3	5.40 ± 0.14	22.70 ± 0.52	3.92 ± 0.33

An inspection of the data in table 1 shows that an application of 6 tons per acre of finely pulverized limestone has caused a change in pH values of the surface soil (plot B) from about pH 4.0 to 5.3. The pH value of the subsoil has been raised from about pH 4.1 to 4.6. When an additional 6 tons of lime and one ton of coral sand per acre were applied in the subsoil, the pH value of the surface soil (plot D) was increased to pH 5.69 and a significant change from pH 4.1 to 5.4 occurred in the sub-soil area.

The mean values for replaceable hydrogen and calcium in the surface soil of unlimed plots A and C are 30.75 ± 1.59 and 0.71 ± 0.02 milligram equivalents per 100 grams of dry soil, respectively

In the sub-soil the values are 28.65 ± 0.31 and 0.67 ± 0.04 milligram equivalents. This gives a ratio of hydrogen to calcium of about 43:1 in the surface soil as well as in the subsoil. Several investigators including Hissink (1923), Gehring, Peggau and Wehrman (1926), Kelly and Brown (1924), and Turner (1930) have found calcium to be the principal exchangeable base in fertile soils.

Pierre (1931) and Pierre and Scarseth (1931) have demonstrated the importance of the relationship of percentage base saturation (i.e. percentage of total base exchange capacity occupied by the soil bases excluding hydrogen) to plant growth. Our soil initially had a total base exchange capacity of 31.48 ± 3.42 milligram equivalents per 100 grams as the mean of unlimed plots A and C in the surface soil and 29.82 ± 0.65 for the sub-soil. The percentage saturation is therefore approximately 2 in the surface and sub-soils, respectively. This calculation is made by using the replaceable calcium values in table. 1.

These percentage base saturation values are extremely low. Since there is such a preponderance of exchangeable hydrogen over the other bases present, these soils would ordinarily be classified as extremely acid and not suitable for plant growth. Growth of weeds and crops on these soils have been below the average. It is of interest to note, however, that in this same field area where the soil pH value is approximately 3.9 that *Crotalaria saltiana* plants occurring as weeds are usually heavily nodulated.

After liming plot B at the rate of 6 tons pulverized limestone per acre the exchangeable calcium content was increased to 6.44 milligram equivalents in the surface soil as shown in table 1. The percentage base saturation was then increased to 20 per cent. Even though this soil might still be considered "sick", its crop productivity was greatly improved as will be shown later. In the limed plot D which received an equal quantity of lime in the surface soil, the percentage base saturation rose from 2 to 19 per cent.

Plot D also received 6 tons per acre of pulverized lime in the sub-soil plus 1 ton per acre of coral sand. This caused the percentage base saturation to rise from 2 per cent to 13 per cent.

GROWTH OF PIGEON PEAS

Pigeon peas were planted broadcast the first part of June, 1931 at the rate of 100 pounds per acre. The effect of lime on the plant

growth was evident almost from the start. At the age of two months, pigeon pea plants on the limed soils were about three times as numerous, one and a half times as tall, and much greener than in the unlimed soils. At the age of four and one half months, an airplane view of the experimental plots was taken. This is shown in figure 1. Limed plots B and D adjoin each other and form the dark block in the center of figure 1 with plot D on the left. Unlimed plots A and C adjoin plot B on the right.

Yields of plant growth were obtained by sampling two 0.003 acre areas in each plot. Top growth included all parts of the plant above the soil surface. Extreme care was taken to extract as much

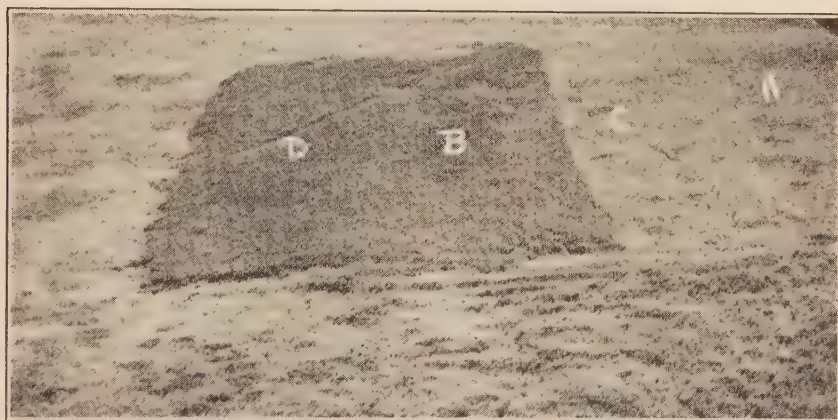


Fig. 1.—Airplane view of pigeon peas (4-1/2 months old) in limed and unlimed areas. Limed areas *B* and *D* form dark block in center. (Courtesy of 11th Photo Section, Air Corps, U. S. Army).

of the root systems as possible from the soil for root mass determinations. The plants at the time of this sampling were about 5 1/2 months old. Yields from equal areas of plots C and D are shown in figure 2. The yields and nitrogen contents of the duplicate samples of each of the plots are given in table 2.

Liming the soil increased the yield of pigeon peas grown thereon three to four times as indicated by table 2. The actual yields obtained, however, were small. This might possibly be explained also by an insufficiency of phosphorus since the soils in plots A, B, C, and D were markedly deficient in available phosphorus. For example,

on another field fertilized with phosphatic fertilizers, approximately five miles distant and at a lower elevation where the soil is less acid, a yield of 34.7 tons green weight per acre has been obtained. These plants were 9 months old at the time of sampling and had a nitrogen content of 500 pounds per acre.



Fig. 2.—Yields of pigeon pea plants (5 1/2 months old) from 0.003 acre area of limed plot D and unlimed plot C.

The best yields were obtained on the least acid soils, as evidenced by plots B and D where yields of 12 tons per acre were obtained with soil pH value of 5.3 to 5.7 in the surface foot. On the more acid soils in plots A and C where the soil pH values were as low as 4.0, the yield was only 3 to 5 tons per acre.

TABLE 2
The yield and nitrogen content of pigeon peas at the age of 5 1/2 months

PLOT	TREATMENT	GREEN WTS. T./A.			DRY WTS. T./A.			PER CENT NITROGEN DRY BASIS	NITROGEN CONTENT LBS./A.		
		Roots	Tops	Total	Roots	Tops	Total		Roots	Tops	Total
A	No lime	1.16	3.66	4.98 \pm 0.11	0.21	1.46	1.67	0.65	2.72	56.22	52.6 \pm 4.3
		2.51	2.63		0.45	1.05	1.50	1.92	5.89	40.32	
B	Limed 6 T./A. surface soil	2.23	9.84	12.22 \pm 0.10	0.51	3.35	3.86	1.20	12.34	197.38	215.4 \pm 3.8
		1.87	10.50		0.43	3.57	4.00	2.95	10.34	210.63	
C	No lime	1.36	2.12	3.00 \pm 0.32	0.37	0.85	1.22	0.57	4.20	29.61	31.7 \pm 1.4
		0.50	2.01		0.14	0.80	0.94	1.75	1.55	28.14	
D	Limed 6 T./A. surface soil 7 T./A. subsoil	2.14	9.09	12.24 \pm 0.67	0.49	3.09	3.58	1.18	11.65	189.14	227.3 \pm 7.7
		1.43	11.82		0.33	4.02	4.35	3.06	7.79	245.96	

Moisture on leaves and stems = 60.0% Plots A, C
 " " " = 66.0% " A, D
 " " " roots " = 54.8% Allplos

NITROGEN CONTENT

The differences in nitrogen contents of the pigeon pea plants of the limed and unlimed soils are very significant. Not only is the total nitrogen content of plants on the limed soils of B and D much greater than on the unlimed soils of A and C but the percentage is also greater. Thus on soils A and C the nitrogen content of the stems and leaves is 1.75 to 1.92 per cent of the dry weight while on soils B and D it varied from 2.95 to 3.06. The nitrogen percentages of the roots of the plants from soils B and D are also to be noted. The prevalence of nodules on the plants from the limed soils B and D probably accounts for such differences. Thus the pigeon pea crops on the unlimed areas A and C contained only 52.6 and 31.7 pounds per acre of nitrogen while those on the limed areas B and D averaged 215.4 and 227.3 pounds per acre, respectively. A difference in plant color of the plots was also noted. The plants on the unlimed soils A and C were always of a yellowish green color as

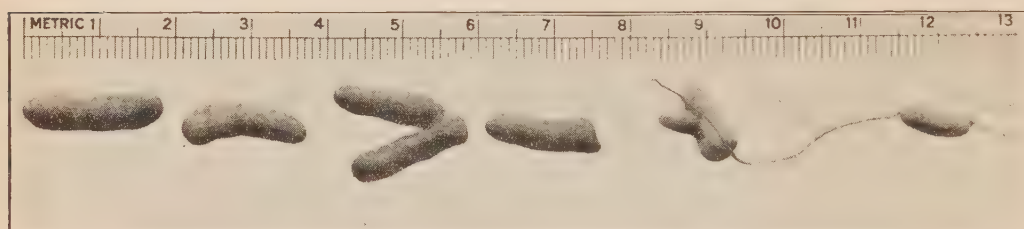


Fig. 3.—Nodules of pigeon pea, *Cajanus cajan* (L.) Millsp. grown in limed area. (Natural size.)

opposed to the dark green color of the plants in the limed soils B and D. It is very likely that the poor plant growth in soils A and C may be interpreted on the basis of pH values and calcium availability since these plots were more acid than those plots receiving lime.

The increase in nitrogen per acre on the limed soils B and D over soils A and C very probably represents a considerable amount of fixed atmospheric nitrogen. This increase represents about 160 pounds nitrogen per acre. Plants obtained from the 0.003 acre sample areas in all the soil plots were examined for root nodules. Nodules were very small and occasional on plants in the unlimed soils A and C. The plants in soils B and D on the other hand contained many large nodules similar to those in figure 3.

It is of course evident that nodule organisms capable of inoculating pigeon pea were present in the soil of all the plots at the beginning of the experiment. Although pigeon peas had never been

grown on this land, various species of *Crotalaria* have always been present as weeds both in pineapple culture and during fallow seasons. According to Richmond (1926) and results of cross-inoculation studies by the authors³ these plants are in the same cross-inoculation group. The liming of soils B and D obviously brought about a more favorable pH range for the growth of the organisms, thus favoring a better inoculation of plants in soils B and D. Figure 3 shows the average type and size of nodules found on plants of limed areas B and D.

Jones (1923) considers 6.25 as the customary factor by which to multiply nitrogen content to obtain proteins. It is probable that various proteins may require other factors. However, using this factor the protein content of the dry pigeon pea stems and leaves is approximately 11 per cent on the unlimed soil as compared with 19 per cent on the limed soil.

SUMMARY

1. The purpose of this study was two-fold: (1) to determine the chemical changes resulting in acid soils used in pineapple culture when lime was applied and (2) to estimate the effect of these changes on crop productivity, using pigeon pea, *Cajanus cajan* (L.) Millsp. as an indicator crop.

2. The following determinations were made on soils from limed and unlimed plots; pH values, replaceable hydrogen, replaceable calcium, total base exchange capacity and percentage saturation.

3. Recorded growth of pigeon pea plants, green weights, dry weights and nitrogen content of the plants in pounds per acre were tabulated.

4. The results warrant the conclusion that lime was very beneficial in restoring the crop productivity of the soils with pigeon peas as an indicator crop. Increases in crop growth were associated with greater soil pH values, more replaceable calcium, and a greater degree of base saturation.

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A BROWN BARK ROT OF CACAO TRUNK ¹

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WITH ONE PLATE AND TWO TEXT FIGURES

THE DISEASE

On November 2, 1930 the senior author found in Los Baños, Laguna, Philippine Islands, a five-year old cacao plant (*Theobroma cacao* L.) attacked by a brown bark rot of the trunk. The infected tree had a trunk about eight centimeters in diameter. The part of the trunk attacked was about twenty-eight centimeters from the surface of the soil. On account of the browning of the tissues underneath the corky layer of the bark the diseased area could be readily seen. It was a darker shade than the rest of the trunk. The brown area formed a belt from 10 to 12 centimeters wide. It encircled the trunk, with the exception of a strip about two centimeters wide. When the corky outside layer of the bark was removed it was noted that the bark was brown and dead clear through from the outer surface to the inner. By means of a sharp knife the bark was carefully removed. In removing the bark it was noted that the browning penetrated the woody tissues in various places. For this reason it was necessary to shave off part of the wood in order to remove all the diseased tissues.

The excised portions of the diseased cacao trunk were brought to the Plant Pathology Laboratory and isolations were made. The isolations yielded a *Fusarium* which produced a perfect stage the characteristics of which belong to the genus *Nectria*.

The disease was responsible for the death of several bearing cacao trees in Los Baños.

Symptoms

The first symptom of the brown bark rot of cacao trunk is the presence of either the dark brown band or irregular brown area which almost completely encircles the trunk of the tree. At first the brown band may have a width of 10 to 12 centimeters but this grows

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in size and becomes irregular in shape through the appearance of other brown patches or the merging together of nearby brown areas. The symptoms are more clearly shown when the corky layer of the trunk is carefully stripped off or shaved with a sharp knife (fig. 1).

Infected trees begin to shed the greater portion of their leaves. The newly formed leaves are smaller than the leaves produced before



Fig. 1.—Part of an infected cacao trunk with some of the bark shaved off to show the browning of the tissues. About $\times 5/7$. (Photograph by the Photographic Division, Department of Soils.)

the trees are infected. When all of the leaves have fallen off, the bare branches begin to die starting at the tips.

One of the most conspicuous effects of the disease is the stimulation of the plants so that they produce an enormous number of flowers. Many fruits are formed from these flowers but they do not

mature. When they reach the size of two to five centimeters in the short diameter they begin to wilt, shrivel and soon die. They lose their hardness so that they can be easily pressed with the fingers. The color of the tissues between the ridges on the pods becomes yellowish so that the larger fruits look as if they were mature. Following the wilting and the yellowing of the pods is a gradual browning and mummifying of the fruits. The dead and mummified fruits persist on the trunk and branches.

Infected trees may live for some time. The upper portion of the trunks may be still green while the infected lower parts will be dead and dry. Diseased cacao trees may remain alive but will be very sickly looking for more than fifteen months from the time the first visible symptoms of the rot appear. These infected trees may retain some of their dull green and small sized leaves. Gradually, the leaves turn yellow and fall off, beginning with the lower older ones. Wilted fruits in their various stages of development may be seen on the twigs, branches and main trunk where they wilt, turn yellow, then brown and dry. These fruits persist on the diseased trees, as in the case of black rot caused by *Phytophthora faberi* Maubl.

CAUSAL ORGANISM

Taxonomy

The writers first thought that the fungus was a *Nectria*, but later on, characters of a *Hypomyces* were exhibited by it. On account of the interest of Dr. H. W. Wollenweber of the Biologische Reichsanstalt für Land-und Forstwirtschaft, Berlin-Dahlem, Germany, foremost authority on *Fusaria*, on the brightly colored ascomycetes and their *Fusarium* stages, a sub-culture of the cacao *Nectria* or *Hypomyces* was sent to him for his opinion on it. In a letter dated August 19, 1931 Doctor Wollenweber stated that "Die von Rindenfaulstellen eines Stammes von *Theobroma cacao* isolierte *Nectria* ist mit *N. haematococca* Berk. et Broome (J. Linnean Soc. XIV, 116. 1873) identisch. Den Pilz habe ich zu *Hypomyces* gestellt und in Angew. Botanik VIII, 191. 1926 als *H. haematococcus* (B. & B.) Wr. bezeichnet. Seine Konidienform stimmt mit *Fusarium Eumartii* Carpenter überein, seine Schlauchform hat dagegen folgende Synonyme: *Nectria Benickiana* P. Hennings, *N. citricola* P. Henn., *N. citri* P. Henn., *N. asperata* Rehm, *N. melanommatis* Sydow and *N. Victoriae* P. Henn..."

In regard to the hosts and geographical distribution of this *Hypomyces haematococcus* on cacao Doctor Wollenweber states"....
Dieser Pilz ist in tropischen Gebieten Asiens, Afrikas und Amerikas verbreitet und bisher auf *Theobroma*, *Coffea*, *Citrus*, *Murraya*, *Cinchona*, *Caesalpinia* und *Adesmia* festgestellt. ..."

According to Doctor Wollenweber it would be of interest if the injurious nature of *Hypomyces haematococcus* could be determined by us by inoculation, because this fungus and the related species *N.*



Fig. 2.—Cacao seedlings used in inoculation with a pure culture of *Hypomyces haematococcus* (B. and Br.) Wr. on July 6, 1931. The inoculated and check plants were placed in the damp chamber for 48 hours and the plants were removed to the shade out of doors. Note that the inoculated plant died while the check was healthy. (Photograph by the Photographic Division, Department of Soils.)

ipomoeae and *N. caneri* are either saprophytes or weak, secondary invaders, so far as literature and experience show in the United States. From experiments on the pathogenicity of the fungus the writers noted that, under damp chamber conditions in the laboratory, the organism is capable of readily causing infection of potted cacao seedlings through wounds on the stems. Cacao seedlings inoculated through injuries on their stems invariably died (fig. 2). No infec-

tion was obtained from inoculation of seedlings on the unwounded stems.

Morphology

Mycelium. The mycelium of the fungus is much branched. On the culture media, the mycelium appears white when young but becomes brownish or nearly so when old. Measurements of more than 25 cells of the mycelium showed that they are $11.7-101.4 \times 2.2-7.8 \mu$.

Conidial stage. In the *Fusarium* stage of the fungus both macro- and microconidia are produced in culture. Both of these conidia are very abundant especially on potato-dextrose agar. The macroconidia are $39.0-62.4 \times 5.5-7.8 \mu$ and the microconidia are $10.3-31.2 \times 3.7-5.2 \mu$.

Ascigerous stage. Perithecia are profusely produced especially in potato dextrose agar (pl. 1, fig. 9). They begin to appear in cultures 15 days old. Many of them are found on the surface of the agar media, although occasionally some perithecia are either half-buried or deeply buried in the agar. They appear singly and scattered or in clumps of from ten to sometimes more than twenty perithecia in a cluster. They are orange to pink in color, ostiolate, usually with prominent beak (pl. 1, fig. 9). The wall consists of loosely and irregularly arranged network markings. The perithecia measure from 300μ to 557.1μ in length and from $214.3-385.7 \mu$ in width. Some fruiting structures which are spherical, smaller than the mature perithecia and borne on the hyphae have been observed. They are similar to the perithecia which Wollenweber² describes and illustrates.

The asci are typically club-shaped, 8-spored, hyaline, arranged in a layer of hymenium within the perithecium with many long and slender paraphyses interspersed with the spore sacs. The ascospores are longer than they are wide and the ends are rounded. They are hyaline, non-septate and granular when young, uni-septate when mature and markedly constricted at the septum. They are arranged end to end in the asci, but occasionally their ends overlap. Young ascospores seem to be held together by a gelatinous material because they continue to retain their original position for some time after the wall of the ascus has been broken (pl. 1, fig. 7). The ascospores are $11.4-16.6 \mu$ in length and $5.3-8.6 \mu$ in width.

² WOLLENWEBER, H. W. 1914. Identification of species of *Fusarium* occurring on the sweet potato, *Ipomoea batatas*. Jour. Agric. Res. 2: 251-286. Pl. 12-16.

WOLLENWEBER, H. W. 1930. *Fusaria autographice delineata*. Tab. 660-1100. See Tab. 832.

Growth in culture

On potato-dextrose agar the growth was moderately rapid, dry at first but later became slimy. The mycelium is depressed sometimes concentric, and pale smoke-gray in color.³

On corn meal the growth was moderately rapid producing a thick mass of mycelium, circular, not slimy, pale brownish vinaceous.

On steamed rice the growth produced a thick mass of mycelium circular in shape with clear margin, dry and vinaceous gray.

On potato plugs there was a rapid growth producing an abundance of whitish aërial hyphae, with an abundance of heaps or masses of spores. The medium became depressed and light vinaceous fawn in color.

On sterilized cacao twigs the growth of mycelium was rapid, scanty and superficial. An abundance of fawn colored masses of conidia was produced.

Tests of the pathogenicity of the fungus

Experiment 1a. On February 12, 1931, healthy cacao seedlings about 45 centimeters tall were obtained from the Department of Agronomy and were inoculated by smearing on the uninjured stem the fungous growth of an eight-day old potato-dextrose agar culture. The checks were smeared with sterile potato-dextrose agar. Both the inoculated and control seedlings were kept inside the damp chamber for five days.

Experiment 1b. On February 12, 1931 small injuries were made on the stem of the healthy cacao seedlings with a sterile scalpel and then the wounded stems were smeared with fungous growth of an eight-day old potato-dextrose agar culture. Small injuries were also made on the stems of the controls, but these were smeared with sterile potato-dextrose agar. Both the inoculated and the check seedlings were kept inside a damp chamber for five days.

Experiment 2. On February 20, 1931, experiments 1a and 1b were repeated following the same methods of inoculation except that 16-day old potato-dextrose agar cultures of the fungus were used.

Experiment 3. On February 27, 1931, experiments 1a and 1b were repeated for the third time following the same technique of inoculation but using 23-day old potato-dextrose agar cultures of the inoculum.

³ Ridgway, R. 1912. Color standards and color nomenclature. 43 p., 53 col. pl. Washington, D. C.

In all cases the seedlings inoculated following method *a* did not produce infection. All seedlings inoculated in experiments 1, 2 and 3 following method *b* became diseased. In experiment 1*b*, a portion of a branch was noted to be infected on the eighth day after inoculation. Five days after infection the diseased area shrivelled and the top of the twig wilted and died. In experiment 2*b* the inoculated area began to show symptoms of infection on the seventh day after inoculation. A few days after infection the stem became covered with whitish fungous growth; the stem began to shrink and the leaves wilted. The seedlings finally died (fig. 2).

In experiment 3*b* the shoots began to die on March 5, 1931. In all of the inoculation experiments performed the checks did not become infected. All check seedlings were vigorous and healthy until the end of the experiment.

On March 22, 1931 the fungus was reisolated from one of the diseased cacao seedlings in each experiment. On March 31, 1931 healthy seedlings were reinoculated following methods described in experiments 1*a* and *b* and using cultures of the fungus obtained in reisolation. The results of these reinoculations were very similar to those obtained in experiments 1*a* and *b*, 2*a* and *b*, and 3*a* and *b*. It was found that the fungus readily infects cacao seedlings through injuries on the stem. Infection took place readily under damp chamber conditions and inoculated plants invariably died of the disease.

From these results it may be seen that in the field in very moist situations during the rainy season cacao trees are likely to become infected by *Hypomyces haematococcus*, possibly through injuries caused by various agencies, such as man, work animals, rats, insects, etc.

CONTROL MEASURES

The disease may be readily controlled by cutting down and burning *in situ* the entire infected tree. In case the whole tree is involved this practice will burn the stump and kill the fungus that is left in it and in the soil around the tree. The wounds made in pruning of branches and harvesting of the pods as well as other mechanical injuries should, at once, be disinfected with either mercuric bichloride solution, formalin solution or Bordeaux paste. The wounds may also be painted with lead paint or coal tar.

Mercuric bichloride solution, Bordeaux paste and white lead paint were used by the writers with good results.

The formulae and methods of preparation of these wound disinfectants that we follow in the Plant Pathology Laboratory in this College are as follows:

Mercuric bichloride solution

Mercuric bichloride crystals	56 grams
Water	57 liters

The mercuric bichloride crystals are first dissolved in a few liters of hot water and the solution is diluted to 57 liters by the addition of tap water.

Formalin solution

One-half liter of commercial formalin, which contains 40 per cent of formaldehyde, is diluted with 150 liters of water.

Bordeaux paste

Copper sulfate or blue vitriol	0.5 kilogram
Stone lime or quick lime	1.0 kilogram
Water	5.8 liters

The stone or quick lime is first slacked in 2.5 liters of water and allowed to cool. The copper sulfate is dissolved in 3.3 liters of hot water and allowed to cool. The two solutions are mixed by pouring the copper sulfate solution into the lime and then stirring vigorously. The paste is usually applied with a brush.

Cacao trees which are sprayed ten times a year with standard Bordeaux mixture prepared by using 1.8 kilogram of copper sulfate, 1.8 kilogram of stone or quick lime and 190 liters of water for the control of black rot of cacao pods and stem canker of cacao caused by *Phytophthora faberi* Maubl. are well protected from the brown bark rot disease.

SUMMARY

1. The brown bark rot of cacao trunk occurs at Los Baños, Laguna, Philippine Islands and is responsible for the death of some of the bearing cacao trees.

2. In addition to the browning and dying of the bark, infected trees shed their leaves. The new leaves that are produced are smaller. The tree is stimulated to produce flowers and fruits. However, the fruits shrivel up before reaching maturity and die. The dead fruits persist on the branches and trunk of the cacao.

3. The disease is caused by *Hypomyces haematococcus* (B. and Br.) Wr., a weak parasite. The fungus causes infection through wounds only.

4. The brown bark rot may be controlled by spraying cacao with fungicides or by painting all wounds on the trunk and branches with disinfectants.

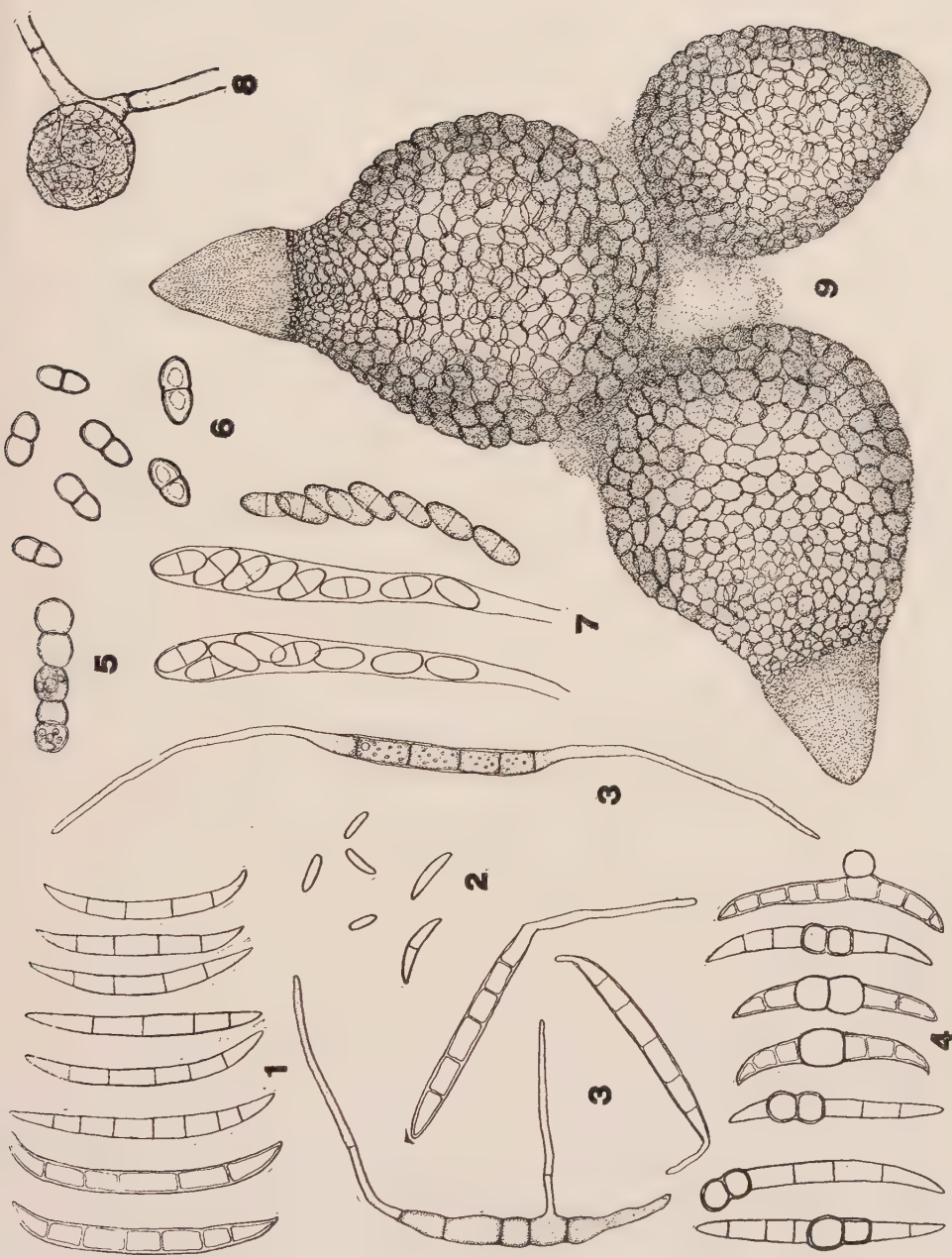


PLATE I

1. Several mature macroconidia of *Hypomyces haematococcus* (E. and Br.) Wr. from 15-day-old potato-dextrose agar culture. 2. Microconidia. 3. Germinating macroconidia in water 16-hour-old. 4. Macroconidia with chlamydospores. 5. A chain of hyphal chlamydospores. 6. Mature ascospores not showing striations. 7. Asci and young ascospores. 8. A very young perithecium. 9. Mature perithecia about 113 X. The drawings for figures 1-8 were made with the aid of a camera lucida using the 60 X high power objective and 13 X ocular of a Reichert microscope. About 280 X. (All drawings by M. S. Celino.)

THE RESISTANCE OF THE EGGS AND LARVAE OF SWINE
KIDNEY WORM, *STEPHANURUS DENTATUS* DIESING,
WITH SPECIAL REFERENCE TO THE CONTROL
OF STEPHANURIASIS ¹

ZACARIAS DE JESUS

Of the College of Veterinary Science

Kidney worm disease of swine, or stephanuriasis, is caused by a nematode colloquially known as swine kidney worm and zoologically known as *Stephanurus dentatus* Diesing, 1839. This worm plague is not only very prevalent but also is the most serious parasitic disease of swine in the Philippine Islands. Newcomb (1913), in his examination of 2,000 hogs slaughtered at the Manila Matadero, discovered that about 50 per cent of the carcasses were infested with *Stephanurus dentatus*. According to this writer, pigs up to the age of 6 or 8 months are rarely found infested while old breeding sows are rarely free from infestation. Gonzalez and Lago (1923) state that observation throughout the Islands has shown that kidney worm infestation is the most serious disease of improved breeds, and this condition is aggravated by the fact that the disease is present in Native pigs and so is widespread. These investigators point out that Native pigs are very resistant to this disease, few if any young Native pigs die from it, but they are a continuous source of infection to foreign pigs.

The most frequently affected organs are the liver and its adjacent tissues and the kidneys together with the leaf lard, or perirenal fat, and the ureters and the periureteral tissues. Because of the location in the body of the host of the infested organs there is no means of dislodging the parasite. Hall (1924) states that there is no known treatment of stephanuriasis, because the site of infestation of *Stephanurus* is beyond the reach of anthelmintics.

While the treatment of incipient cases of experimental liver infestation is promising, as reported by Kauzal (1932), the treatment of cases of leaf lard infestation, because of the very poor blood supply,

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The writer is indebted to Dr. Gregorio San Agustin, Dean of the College of Veterinary Science, for his encouragement and for supplying him with material for this study.

seems impossible owing to the anatomical inaccessibility of this tissue to the anthelmintics. Moreover, in the present stage of our knowledge, there is no means of determining *intra vitam* whether the worms are all in the liver or in the perirenal fat also. The sexually immature worms in the liver, according to Schwartz and Price (1929), migrate to the perirenal fat, by passing out through the liver capsule and from the abdominal cavity entering the perirenal fat where they reach sexual maturity. Hence, the individuals suffering from liver infestation with *Stephanurus* are as dangerous a source of infection as those having infested leaf lard. Swine harboring the worms in their perirenal fat and periureteral tissues act as disseminators of the eggs of *Stephanurus*, because in these locations, by boring fistulous tracts, the worms can easily reach the upper urinary passages where they can discharge their eggs which reach the outside with the urine. As the eggs can be demonstrated only in the urine of infested hogs, the diagnosis of stephanuriasis is quite difficult. The diagnosis of cases of liver infestation is even more difficult, if not impossible. Therefore, at present, it is of no practical value to the hog raisers to institute preventive measures by attempting to diagnose the condition or to kill the worms as they are in their invulnerable locations.

The eggs of *S. dentatus* are hatched outside the body in wet places in the hog pen, such as the hog wallow, mud holes and wet muddy floor where the larvae reach their infective stage in about seven days. Infection is effected through either one or both of the two portals of entry; namely, (1) through the mouth with the food and water or (2) through the scarified or bruised skin as determined by Schwartz and Price (1931).

In this particular parasite, the most vulnerable stages in its life cycle, from the standpoint of controlling the infestation, are the eggs and the larvae. The objects of the present study were (a) to determine the resistance of the eggs and larvae of *Stephanurus dentatus* when subjected to adverse or to favorable conditions and (b) to find some practical methods of controlling kidney worm disease of swine by using solutions of cheap easily obtained materials.

MATERIALS AND METHODS

Through the courtesy of Director Stanton Youngberg of the Bureau of Animal Industry and with the aid of Doctors Juan C. David and Nicolas S. Sevilla and their assistants at the Azcarraga Mat-

adereo in Manila, the writer was able to collect a large number of mature swine kidney worms, *Stephanurus dentatus*, at long intervals in 1930, 1931 and 1932. The worms were removed in the late afternoon from the infested perirenal fat of hog carcasses and immersed in physiological salt solution in a wide-mouthed bottle, and set aside over-night.

The next morning the gravid females were selected and placed in a Petri dish. The eggs, which were found in large numbers at the bottom of the container, were transferred with a pipette to a watch glass. These eggs were evidently laid by the worms during the night. With the aid of a pair of fine scissors and a pair of small tissue forceps, the head and tail ends of the worms were clipped off and discarded; and the middle portions containing the gravid uteri were chopped up finely to liberate the eggs. The eggs thus liberated together with the fine pieces of the middle portions of the bodies of the worms and the eggs naturally discharged were mixed. A little amount of boiled fecal extract was added to form a suspension of eggs such that one cubic centimeter of this suspension should contain about three hundred eggs.

In order to have a supply of *Stephanurus* larvae, a portion of the suspension of eggs was placed in a small jar, 2-1/2" × 2", and enough boiled water was added to completely immerse the eggs. About one cc. of boiled fecal extract was also added. The medium was changed every second day. The culture was kept in the room at a temperature of from 27.3° to 32.2°C. At the end of three days, all the developing eggs were hatched.

The fecal extract was prepared by boiling for thirty minutes a small amount of pig feces in five times its volume of water and filtering the supernatant fluid through a thin layer of cotton. The dust used in three experiments contained for the most part very fine gravel. This was boiled in water for one hour and then dried in the sun.

Crude common salt (sodium chloride) known vernacularly as *asin*, prepared in the Philippines by evaporating the sea water in the open during the dry season, was principally used in this study. This salt can be obtained in large quantities and at a low price, five centavos for three liters (one ganta), or about two kgm. Solutions of 2 to 10 per cent of this salt were prepared in 200 cc. quantities using tap water. Solutions of copper sulfate, or blue stone of commercial quality, varying in proportion from 1 to 500 to 1 to 15,000 were used. This drug is now sold at ₱1.20 per kgm. One per cent solu-

tion of Jeye's Fluid or Creolina, Botica Boie, which is a creolin of poor quality, was used in the disinfection experiment. This disinfectant is very cheap costing P5.00 for a five-gallon can. It is recommended for use as disinfectant and insect repellent for chicken coops, dog stalls, stables and other animal habitations.

In every trial in the different experiments the treated eggs and larvae were cultured under favorable conditions. The medium used was physiological salt solution prepared by dissolving 0.85 gram of sodium chloride, chemically pure, in 100 cc. of boiled tap water and adding 10 cc. of fecal extract. Five to ten cc. of the medium were used. The medium was changed every second day. The cultures were kept at room temperature and examined daily for seven days. The eggs or larvae were "fished" from each culture and three to five slide preparations were examined under a compound microscope at magnification of $100\times$ and $440\times$, searching particularly for evidence of development of the eggs and for vitality of the larvae or for signs of decomposition of their bodies.

EXPERIMENTS AND RESULTS

Experiment 1: On the relative effect of the solutions of common salt on the vitality of the eggs. One-half cubic centimeter of the suspension of eggs was placed in each of four test tubes, $6'' \times 3/4''$, and to each tube was added 20 cc. of a solution of crude common salt (sodium chloride). The test tube was rolled between the palms of the hands to mix thoroughly the eggs with the solution. After a time interval of six hours, the salt solution was pipetted off from the test tube in such a way that the sediment, which contained the eggs, was not disturbed. Immediately, 20 cc. of boiled tap water were added to the sediment, and one hour later the water was pipetted off and another 20 cc. of water were added and again pipetted off in order to remove much of the salt. One-half cubic centimeter of fecal extract was added to the eggs in the sediment and set aside for development. The experiment was repeated under similar conditions. The results are shown in table 1.

The sign (+) indicates total lack of deleterious effect on the vitality of the eggs which hatched into larvae in the cultures, the sign (-) indicates destructive effect on the eggs with no sign of development of the eggs in the culture, and the sign (\pm) indicates lack of destruction in one trial and total destruction of the eggs in another trial.

Experiment 2: On the relative effect of the solution of copper sulfate on the vitality of the eggs. One-half cubic centimeter of the suspension of eggs was placed in each of 20 test tubes, $6'' \times 3/4''$, and to each tube were added 20 cc. of a solution of copper sulfate (commercial). The same technique as in experiment 1 was followed for the rest of the experiment. The results are shown in table 2.

Experiment 3: On the effect on the eggs of exposure to dryness in the shade. The bottom of each of four watch glasses, $2'' \times 1/2''$, was covered with a layer of dust 3 mm. deep. One cubic centimeter of the suspension of eggs in water was scattered drop by drop on the layer of dust. These watch glass preparations were kept in a room near an open window on the leeward side of the building at room temperature ranging from 28.5° to 31.5°C . They were prepared and exposed at about the same time. After every time interval of three hours one watch glass preparation was flooded with physiological salt solution. The eggs were examined immediately after exposure for changes that may have taken place and for their development in the culture. The results are shown in table 3.

Experiment 4: On the effect on the eggs of the exposure to dryness in bright sunlight. Eight watch glass preparations were made as in experiment 3. These were exposed at the same time to bright sunlight between two and four in the afternoon when the room temperature was 31.5°C . After every time interval of ten minutes one watch glass preparation was removed from the sunlight and flooded with physiological saline. The eggs were examined for physical changes immediately after exposure and then set aside for development. The results are shown in table 4.

Experiment 5: On the effect of exposure to bright sunlight on the vitality of the eggs which are constantly supplied with moisture. Ten watch glasses were prepared as in experiment 3. In each watch glass was scattered drop by drop one cc. of suspension of eggs and to this were added two cc. of boiled tap water, containing a little amount of fecal extract, as medium. These watch glass preparations were exposed at the same time to bright sunlight when the temperature under the shade was from 28.5° to 31.5°C . A Petri dish, $4'' \times 1/2''$, was filled with boiled water and placed beside the watch glass preparations. In order to insure a constant supply of moisture, the water in the watch glasses was replenished every 20 minutes with water from the Petri dish. These preparations were exposed to bright sunlight from one to ten hours. After a time interval of one

hour one watch glass preparation was removed from under the sun and then partly filled with physiological salt solution.

After examining the eggs, they were set aside for development. No physical changes whatsoever were observed on the eggs. Nearly all of them in the 10 watch glass preparations developed and hatched into vigorous larvae.

Experiment 6: On the relative killing power on the larvae of the solutions of crude common salt. With a 10 cc. pipette, 6 cc. of the sediment in a culture containing infective and non-infective larvae were placed in each of nine seeding tubes. By several trials, it was found that one-half cubic centimeter of the sediment contained about 20 to 30 larvae. Ten cc. of a solution of crude common salt were added to each tube. After a time interval of one hour, one-half cc. of the sediment was transferred from the seeding tube to a test tube containing 20 cc. of boiled water, scattering the sediment in the water as it was discharged from the pipette. Two hours later most of the water was pipetted off and replenished. Some fecal extract was added to the medium in each tube. The tubes were examined for living larvae soon after exposure and every day for three days. This experiment was repeated under similar conditions.

The results are shown in table 5. The sign (+) indicates that the larvae remained alive, the sign (-) indicates that all the larvae were found dead, and the sign (\pm) indicates that the larvae were found dead in one trial but living in another trial.

Experiment 7: On the relative killing power on the larvae of the solution of copper sulfate. In this experiment, the seeding tubes were prepared as in experiment 6, except that instead of using crude common salt solutions, copper sulfate (commercial) solutions were used. The same procedure of testing the killing power was also followed. The results are shown in table 6.

In two instances the larvae were exposed for 24 hours to solutions of 1 to 10,000 and 1 to 15,000. The first solution killed the larvae after an exposure of 20 hours, whereas the second did not kill the larvae even after 24 hours.

Experiment 8: On the effect on the vitality of the larvae of dryness in bright sunlight. Six watch glasses were prepared as in experiment 3. Two cc. each of the sediment, in the culture containing infective and in the one containing non-infective larvae, were scattered drop by drop on the layer of dust in each of the watch glasses. These preparations were exposed at the same time to bright sunlight between three and four o'clock in the afternoon. The tem-

perature under the shade was 29.5°C. After an interval of five minutes one watch glass preparation was taken to a room and flooded with physiological saline solution and set aside for culture. The cultures were examined for living larvae soon after exposure and then every 12 hours for 2 days.

All the larvae in the preparations which were exposed to bright sunlight for 5 minutes and 10 minutes remained alive; most of those exposed for 15 minutes were found dead. All those exposed for 20 minutes, 25 minutes, and 30 minutes were found dead. This experiment was repeated under similar conditions and the same results were obtained.

Experiment 9: On the effect of bright sunlight on the vitality of the larvae which were constantly supplied with moisture. Ten watch glass preparations were made as in experiment 8. But the dust in the watch glasses was liberally moistened with water. The preparations were exposed to bright sunlight between seven in the morning and five in the afternoon. The temperature in the shade was from 28.5° to 32.4°C. As in experiment 5, a Petri dish was filled with boiled water and placed beside the watch glasses. With this water the dust was moistened liberally every 20 minutes. After an interval of one hour, one watch glass preparation was taken to a room and flooded with physiological salt solution.

The preparations were examined for living larvae. It was found that, even after an exposure of 10 hours, the larvae remained alive and active.

Experiment 10: On the determination of the killing power of one per cent solution of creolin (Jeye's Fluid) on the eggs and larvae. Three seeding tubes were prepared, the first for the eggs, the second for the first stage larvae, and the third for the infective larvae. In the first case, 5 cc. of suspension of eggs were placed in a test tube. In the second case, 5 cc. of the sediment of a three-day old culture were used. This culture contained the first stage larvae which were devoid of sheath, that is, they had not reached the first lethargus in the second stage of the larval development. In the third case, approximately ten-day old larvae which had passed their second lethargus, were used. These were the third stage larvae, or the infective larvae. To each seeding tube, 25 cc. of a one per cent solution of creolin (Jeye's Fluid, Botica Boie) were added. After an interval of five minutes, with a pipette, one-half cc. of the sediment in each seeding tube was transferred to a test tube containing 20 cc. of boiled water. One hour later, the water in the tubes was pipetted off with-

out disturbing the sediment, to which was then added 5 cc. of saline solution and a little fecal extract. The cultures thus prepared were examined every day for 7 days in case of the eggs; in case of the larvae, soon after exposure and every 12 hours thereafter. This experiment was repeated. The results are shown in table 7.

Experiment 11: On the determination of the longevity of the infective larvae. The bottom of a 150 cc. beaker was covered with dust forming a layer about 3 mm. deep. Five cc. of the suspension of eggs, 15 cc. of boiled water, and one cc. of the fecal extract were mixed in the beaker. The culture was kept at room temperature, and the medium was changed every third day throughout the experiment. After six days the larvae in the culture were found to be covered with sheaths and were inactive, that is, they were still in their second stage of larval development. Two days later, the larvae were found to be free from their sheaths and were very active. These were the third stage larvae, or the infective larvae. Their longevity was reckoned from the time they were noticed in the culture, and their vitality was observed, under the microscope, every day, morning and afternoon.

About one-half of the number of infective larvae had died by the forty-seventh day. On the fiftieth day, only very few larvae could be found in the culture, and on the fifty-seventh day only dead or decaying larvae could be found.

DISCUSSION OF RESULTS

Relative effect of the solutions of crude common salt on the vitality of the eggs

As shown in table 1, certain solutions of crude common salt can be used to advantage in the destruction of the vitality of the eggs of *S. dentatus*. According to Milks (1930), a strong solution of sodium chloride abstracts water from the cells. The eggs in this case were evidently destroyed by the dehydration of the egg content. The 4 per cent solution completely destroyed the vitality of the eggs after an exposure of 24 hours. The difference in results in the first and second trials was probably due to the difference in moisture content of the samples, because high moisture content will greatly increase the weight of the sample. However slow the destructive action may be, this solution can be used instead of plain water in the hog wallow so as to destroy the eggs of *S. dentatus*, which are voided out with the urine of the infested swine, provided the solution be changed

after 24 hours. Higher solutions destroyed the eggs in from 6 to 18 hours. But because of the cost it is not advisable to use higher than 4 per cent solution.

Using the 4 per cent solution in a hog wallow holding 125 gallons of water, the amount of crude common salt needed is 20 kgm. which would cost about 30 centavos. If no specially constructed hog wallow is provided, the hogs will surely wallow in large mud holes or make their own wallows in muddy spots. Hence, empty mud holes should be filled with 4 per cent solution of common salt; and this liquid need not be changed. If the mud holes are already filled with water, it would be necessary to put enough salt in the water to make a 4 per cent solution. Except that it is very insanitary, this is a much cheaper method than with a specially constructed hog wallow. The treated mud holes may be of practical value to the average hog raiser.

Milks (1930) states that salt causes some irritation on the skin. But the writer found that this is not true with dilute salt solutions. Four pigs were bathed every day morning and afternoon with a 4 per cent solution of crude common salt. A hog wallow provided for a sow and boar was filled with this solution every four days. After two weeks, no untoward effects on their skin nor symptoms of poisoning were observed.

Relative effect of the solutions of copper sulfate (commercial) on the vitality of the eggs

Table 2 shows that dilute solutions of copper sulfate (commercial) are detrimental to the vitality of the eggs of *S. dentatus* after a long exposure. Copper sulfate is an astringent in dilute solutions, caustic in concentrated ones (Milks, 1930). Most of the eggs that lost their vitality incident to exposure to copper sulfate solution were found to have contracted shells and contents. This contraction must be due to the astringent effect of the drug, which effect is favored by the thinness of the shell of the eggs. Since the 1:10,000 solution destroyed the vitality of the eggs after an exposure of 24 hours, if the result warrants the cost, this solution may be used in the hog wallow instead of the 4 per cent solution of crude common salt. As 1:2,000 solution destroyed the vitality of the eggs in 6 hours, it may be used in the disinfection of hog houses and in spraying moist places suspected of infection. Empty mud holes in the hog pen should be filled with 1:10,000 solution, and in those that are already filled with water enough copper sulfate powder should be broadcast on the water to make the desired solution approximately.

To make 125 gallons of 1:10,000 solution in water, 50 grams of copper sulfate are needed, and this costs about six centavos. In view of the copper sulfate (commercial) solution costing less than the crude common salt solution, for use in the hog wallow, the copper sulfate is preferable.

The 1:10,000 solution of copper sulfate (commercial) is not harmful to the pigs. Four pigs were bathed with this solution in the morning and in the afternoon for two weeks. Two of these pigs were allowed to drink *ad libitum* this solution every 4 days for 20 days. In no case was there observed any symptoms of poisoning or any lesions produced on the skin of the pigs.

Effect of exposure of the eggs to dryness in the shade

Exposure to dryness, even in the shade, as shown in table 3, is highly deleterious to the eggs of *S. dentatus*. This treatment produced injurious physical changes in the eggs. Owing to drying up, the shells were wrinkled, and large bubbles were produced in the contents of the eggs after an exposure of 9 hours; the eggs were no longer viable. This result shows that, because of the thinness of the shell of the egg, the content is easily dried up even in the shade. The vitality of these eggs is destroyed. This effect on the eggs suggests that in the control of stephanuriasis there is need of good drainage in the hog pen as well as the necessity of having a well drained and well ventilated room in the hog house.

Effect on the eggs of exposure to dryness in bright sunlight

Dryness and bright sunlight are highly destructive to the vitality of the eggs of swine kidney worm. Table 4 shows that an exposure to dryness in bright sunlight for 30 minutes entirely destroyed the vitality of the eggs. Longer exposures so totally dried up the eggs that their physical identity was lost, showing the very low resistance of the eggs to this adverse condition. This result points to the importance of exposing the premises to bright sunlight so as to effectively dry them, and, consequently, thus destroy the eggs of this parasite.

Effect of exposure to bright sunlight on the vitality of the eggs which are constantly supplied with moisture

A constant supply of moisture is evidently an important factor not only in the development but also in the protection of the eggs from the effect of bright sunlight. Bright sunlight alone is not dele-

terious to the eggs, because even an exposure of 10 hours, under this particular condition, did not affect their vitality nor inhibit their development.

Relative killing power on the larvae of the solution of crude common salt

The larvae of *S. dentatus* are more susceptible to 3 per cent solution of crude common salt after a long exposure than the eggs. After an exposure of 11 hours, as shown in table 5, this solution killed the infective larvae. Solutions containing 4 and 5 per cent common salt killed the larvae after an exposure of 2 hours, while 6 and 7 per cent solutions of common salt positively killed the larvae after 1 hour. In three trials, 7 per cent salt solution killed the larvae after 30 minutes. In view of these results, a 4 per cent solution of crude common salt, if allowed to act for 12 to 24 hours, may be used in the hog wallow for the purpose of destroying both the eggs and the infective larvae. For spraying the muddy places on the premises, the 5 per cent solution should be used so as to allow for its being automatically diluted. Even if its concentration is reduced to less than 4 per cent the concentration will be raised to 4 per cent or higher in a short time, except on rainy days, through evaporation of the water content of the solution. In rainy weather, spraying should be repeated after an interval of 4 days, which period covers the preparasitic stages of the larvae. Schwartz and Price (1929) report that the preparasitic stages of the larvae of *S. dentatus* are completed in from 5 to 6 days. In the light of this fact and for the sake of economy, spraying of the wet and muddy places in the hog pen, should be done at least every 4 days. If the water in the hog wallow is emptied into a well drained and easily dried ground, the common salt solution or copper sulfate solution in the hog wallow may also be used once every 4 days.

Relative killing power on the larvae of the solutions of copper sulfate

As shown in table 6, the 1:1,000 solution of copper sulfate (commercial) killed the larvae after an exposure of 6 hours; the 1:5,000 solution after 10 hours. Hence, these solutions can be used for spraying the wet and muddy places. Since the 1:10,000 solution can kill the larvae after an exposure of 20 hours, using this solution in the hog wallow, will not only destroy the vitality of the eggs but also kill the larvae.

Effect on the larvae of dryness in bright sunlight

The larvae of *S. dentatus* died after 20 minutes when in a well drained container and exposed to bright sunlight. Moisture is indispensable to the existence of the larvae just as it is for the vitality and development of the eggs. If dryness is detrimental to the vitality of the eggs, it must be far more so to the life of the larvae as they derive their oxygen supply from the moisture around the skin and obtain their food from the liquid medium containing dissolved organic matter. Owing to the lack of a thick skin covering to prevent evaporation and to its microscopic size, the larvae very readily succumb to dryness, especially under bright sunlight.

Effect of bright sunlight on the larvae when constantly supplied with moisture

Since an exposure of 10 hours did not do any harm to the larvae which were constantly supplied with moisture, obviously, bright sunlight alone is not harmful to them. Bright sunlight, however, greatly hastens the drying up of wet premises thereby indirectly killing the larvae. Hence, good drainage, good ventilation, and exposure to sunlight must go hand in hand to effectively kill the larvae, or, at least, minimize their number on infected premises.

Killing power of one per cent solution of creolin (Jeye's Fluid) on the eggs and larvae

According to Bastedo (1932), creolin is a proprietary remedy similar in nature to the compound cresol solution. Its main action, then, is that of cresol. It is probable that the creolin solution penetrates the shell of the egg or the skin of the larvæ, and being a poison, kills the cells by poisoning the protoplasm. As shown in table 7, one per cent solution of creolin (Jeye's Fluid, Botica Boie) destroyed the vitality of the eggs after an exposure of 15 minutes. It killed the first stage larvae in 10 minutes and the third stage, or infective larvae, in 30 minutes. On the basis of this result, the use of this particular quality of creolin in the hog house and hog pen should have a triple purpose; namely, as a fly repellent, as a disinfectant and, above all, as an agent to destroy the eggs and the larvae of swine kidney worm.

Longevity of the infective larvae

The third stage or infective larvae are the only ones that can effect infection. As shown by Schwartz and Price (1931), the larvae enter the body of the victim either by passing through the mouth or

by penetrating the scarified, bruised, or otherwise injured skin. The same investigators (1931) point out that the infective larvae of *Stephanurus dentatus* are incapable of penetrating the intact skin of pigs. According to these writers (1932), whichever route is taken by the larvæ in entering the body of the pig, the same course of migration in the visceral organs is followed and the same lesions are produced.

In view of the ability of the infective larvae to remain alive in wet places for 56 days or probably longer, there is a very great possibility for these larvae to gain access into the body of the victim either by being swallowed with the food and water or by penetrating the injured portions of the skin. This situation is greatly favored by the peculiar habits of pigs of wallowing in mud holes and of eating some dead and some living small animals in wet places in the hog pen. Furthermore, lousy or mangy pigs rub the itchy parts of their body against posts, walls, or trunks of trees thereby causing scarification, bruises or other injuries to the skin. Whether they have an injured skin or not they usually wallow or lie in wet places, especially on hot days. Hence, the resistance of the larvae and the peculiar habits of the pigs are two important factors which may reduce the effectiveness of control measures against swine kidney worm infestation.

SUMMARY OF CONCLUSIONS

1. The eggs of *Stephanurus dentatus* lost their vitality after an exposure of 24 hours to a 4 per cent solution of crude common salt, and the larvae were killed after an exposure of 11 hours to 3 per cent solution.

2. A 1:10,000 solution of copper sulfate of commercial quality destroyed the vitality of the eggs of *S. dentatus* after an exposure of 24 hours and killed the larvae after an exposure of 20 hours.

3. Using a 4 per cent solution of crude common salt or a 1:10,000 solution of copper sulfate in the hog wallow will not only destroy the vitality of the eggs but also kill the larvae.

4. If the hogs wallow in the mud, the mud holes should be filled with either a 4 per cent solution of crude common salt or a 1:10,000 solution of copper sulfate, and in case the mud holes are filled with water, enough common salt or copper sulfate powder should be added to make approximately the desired solution.

5. The existence of a wallow in the hog pen should be discouraged, if its use can possibly be dispensed with, as it is a favorable

place for the development of the eggs and for the existence of the larvae.

6. For spraying the wet places in the hog pen, a 5 per cent solution of crude common salt or a 1:5,000 solution of copper sulfate should be used in order to give allowance for dilution.

7. Owing to the thinness of the shell, the content of the egg was dried up in 9 hours when exposed to dryness even in the shade and its vitality was completely destroyed.

8. Exposure to dryness in bright sunlight for 30 minutes destroyed the vitality of the eggs, and longer exposures so dried up the eggs that their physical identity was lost; which shows their low resistance when subjected to this adverse condition.

9. Since dryness is highly detrimental to the vitality and development of the eggs, and to the life of the larvae, good drainage, good ventilation, and sunlight in the hog house as well as the hog pen are three conditions that will greatly reduce the number of infective larvae on the premises.

10. As a one per cent solution of creolin (or Jeye's Fluid, Botica Boie) can destroy the vitality of the eggs and larvae in from 15 to 30 minutes, the frequent use of this disinfectant in the hog house and hog pen will greatly help in the control of kidney worm disease of swine.

11. Knowing the period covered by the preparasitic stages of the larvae of *S. dentatus* the common salt or the copper sulfate solution in the hog wallow and the creolin solution for spraying will be effective if repeated every 4 days.

12. As the infective larvae can live outside for 56 days, or probably longer under more favorable conditions, their chances of invading the body of the victim are very great; and these chances are greatly favored by the peculiar habits of pigs.

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TABLE 1

Showing the relative effect of the solutions of crude common salt on the vitality of the eggs of Stephanurus dentatus

SOLUTIONS	TIME IN HOURS OF EXPOSURE OF THE EGGS				CONTROLS
	6	12	18	24	7 days
<i>per cent</i>					
2	+	+	+	+	+
3	+	+	+	±	+
4	+	+	±	—	+
5	+	±	—	—	+
6	±	±	—	—	+
7	—	—	—	—	+
8	—	—	—	—	+
9	—	—	—	—	+
10	—	—	—	—	+

TABLE 2

Showing the relative effect of the solutions of copper sulfate on the vitality of the eggs

SOLUTIONS	TIME IN HOURS OF EXPOSURE OF THE EGGS				CONTROLS
	6	12	18	24	7 days
<i>proportion</i>					
1:1,000	—	—	—	—	+
1:2,000	—	—	—	—	+
1:3,000	±	—	—	—	+
1:4,000	+	±	—	—	+
1:5,000	+	±	—	—	+
1:6,000	+	+	—	—	+
1:7,000	+	+	—	—	+
1:8,000	+	+	—	—	+
1:9,000	+	+	±	—	+
1:10,000	+	+	±	—	+
1:11,000	+	+	+	±	+
1:12,000	+	+	+	+	+
1:13,000	+	+	+	+	+
1:14,000	+	+	+	+	+
1:15,000	+	+	+	+	+

TABLE 3

Showing the effect on the eggs of exposure to dryness in the shade

TIME IN HOURS	PHYSICAL CHANGES	DEVELOPMENT
3	Shells wrinkled, contents normal	Embryonated and hatched
6	Shells wrinkled, contents contracted	Embryonated and hatched
9	Shells wrinkled, contents with bubbles	None
12	Shells wrinkled, contents with large bubbles	None
Control	None	Embryonated and hatched

TABLE 4

Showing the effect on the eggs of exposure to dryness in bright sunlight

TIME IN MINUTES	PHYSICAL CHANGES	DEVELOPMENT
10	None	Embryonated and hatched
20	Shells wrinkled	Embryonated and hatched
30	Shells wrinkled, contents with bubbles	None
40	Shells wrinkled, contents with bubbles	None
50	Shells wrinkled, contents with bubbles	None
60	Shells broken, contents dried and broken	None
70	Shells and contents lost physical identity	None
80	Shells and contents lost physical identity	None
Control	None	Embryonated and hatched

TABLE 5

Showing the relative killing power on the larvae of the solutions of crude common salt

SOLUTIONS per cent	TIME IN HOURS OF EXPOSURE OF THE LARVAE												CONTROLS
	1	2	3	4	5	6	7	8	9	10	11	12	7 days
2	+	+	+	+	+	+	+	+	+	+	+	+	+
3	+	+	+	+	+	+	+	±	±	±	—	—	+
4	±	—	—	—	—	—	—	—	—	—	—	—	+
5	±	—	—	—	—	—	—	—	—	—	—	—	+
6	—	—	—	—	—	—	—	—	—	—	—	—	+
7	—	—	—	—	—	—	—	—	—	—	—	—	+
8	—	—	—	—	—	—	—	—	—	—	—	—	+
9	—	—	—	—	—	—	—	—	—	—	—	—	+
10	—	—	—	—	—	—	—	—	—	—	—	—	+

TABLE 6

Showing the relative killing power on the larvae of the solutions of copper sulfate (commercial)

SOLUTIONS proportion	TIME IN HOURS OF EXPOSURE OF THE LARVAE												CONTROLS
	1	2	3	4	5	6	7	8	9	10	11	12	
1:500	+	±	±	—	—	—	—	—	—	—	—	—	+
1:1,000	+	+	+	±	±	—	—	—	—	—	—	—	+
1:5,000	+	+	+	+	+	+	+	+	±	—	—	—	+
1:10,000	+	+	+	+	+	+	+	+	+	+	+	+	+
1:15,000	+	+	+	+	+	+	+	+	+	+	+	+	+

TABLE 7

Showing the killing power of one per cent crocolin (Jeye's Fluid) solution on eggs and larvae

	TIME IN MINUTES OF EXPOSURE										CONTROLS
	5	10	15	20	25	30	35	40	45	50	
Eggs	+	±	—	—	—	—	—	—	—	—	+
Larvae, first stage	±	—	—	—	—	—	—	—	—	—	+
Larvae, infective	+	+	+	±	±	—	—	—	—	—	+

A STUDY OF THE OCCURRENCE OF AZOTOBACTER FLORA IN SOME PHILIPPINE SOILS ¹

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WITH TWO TEXT FIGURES

Since the discovery of the non-symbiotic nitrogen-fixing bacteria of the genus *Azotobacter*, there have been numerous investigations of their morphological, cultural and physiological characteristics. The results of various studies showed that the *Azotobacter* organisms are of great importance from the standpoint of soil fertility owing to the addition of an appreciable amount of nitrogen to the soil as a result of their activities. The occurrence and activities of these organisms in Philippine soils has not, as yet, been given much attention.

In this study, the writers call attention to the apparent close correlation existing between the absolute reaction of a soil extract and the presence of *Azotobacter* in the soil. The data as summarized by Gainey and Bachelor (1923) from the work of Gomez show that when the soil extract becomes more acid than pH 6.0 the soil, with few exceptions, fails to initiate the growth of *Azotobacter*. On the other hand, when the hydrogen ion of the soil extract was less acid than pH 6.0, the cultures almost always developed typical *Azotobacter* films.

REVIEW OF LITERATURE

According to Aquino (1931) Beijerinck, isolated and described the first *Azotobacter* organisms, one of which he named *Azotobacter chroococcum* and the other *Azotobacter agile*. The first was an aerobic organism isolated from the soil and the second from a sample of water. Beijerinck claimed that the isolated pure cultures of *Azotobacter* were able to fix the atmospheric nitrogen in appreciable amounts.

¹ Part of the material in this paper was reported in a thesis presented, October, 1931, by the junior author, for graduation with the degree of Bachelor of Agriculture from the College of Agriculture. Thesis No. 341; Experiment Station contribution No. 876. Received for publication, July 7, 1932.

Lipman (1903) added a third species, *Azotobacter vinelandii*, to the list and in the following year he isolated and described two more, giving them the names of *Azotobacter beijerinckii* and *Azotobacter woodstownii*. Of the five organisms isolated and studied, *Azotobacter chroococcum*, *Azotobacter beijerinckii* and *Azotobacter vinelandii* are considered the most important in soil inoculation studies.

According to Emerson (1918), Christensen found that *Azotobacter* organisms are present throughout northwestern Europe, the activity of the organisms apparently depending on the basicity of the soil; this view is supported by several investigators.

Waksman (1927) reports that the *Azotobacter* organisms occurred in most soils studied and that their activities are greatly influenced by the reaction of the soil.

Walker and Brown (1930) show that the organisms of the genus *Azotobacter* are found to occur in some Iowa soils. These authors state that these organisms are very sensitive to environmental conditions, that is, they seldom occur or they are inactive in soils with an acidity greater than pH 6.0. Aquino (1931) reports that organisms of the genus *Azotobacter* occur in some Philippine soils.

OBJECTS OF THE PRESENT WORK

The objects of the present work were: (a) to study the occurrence of *Azotobacter* flora in some Philippine soils; (b) to determine the influence on the growth and development of *Azotobacter* colonies of lime, calcium carbonate (CaCO_3), potassium chloride (KCl), and mono-potassium phosphate (KH_2PO_4) added to media.

TIME AND PLACE OF THE PRESENT WORK

This work was conducted in the laboratory of the Department of Soils, College of Agriculture, University of the Philippines from April to October 1931, thus covering a period of about six months.

MATERIALS AND METHODS

The soils used in this work were collected from the "Maquiling Area" in the municipalities of Calamba, Sto. Tomas, Tanauan, San Pablo, Alaminos, Bay and Los Baños, island of Luzon, Philippine Islands. These soil samples were obtained by the previous thesis students in the Department of Soils who, in the course of the soil survey of this area, surveyed the different municipalities.

One of the greatest difficulties in the study of the non-symbiotic nitrogen-fixing bacteria of the soil before Winogradsky's work with soil microorganisms was the lack of suitable methods. As a result of the recognition of his work on the soil microorganisms, much attention has been directed to the study of methods and several have been proposed. One of the earliest methods involved merely the measurement of the increase in nitrogen in a sample of soil that was held under optimum soil conditions for a definite length of time, usually about 30 days. The various methods which had been widely used were suggested by Remy, as stated by Walker and Sullivan (1930).

Winogradsky's direct method for the demonstration of the occurrence of *Azotobacter* flora in soil, as followed by Aquino (1931), was employed in this study.

The soil samples were prepared as follows: Each of the samples of surface and subsoil was mixed thoroughly, pulverized and passed through a one-half millimeter sieve. The sample thus prepared was then used for duplicate determinations. The treatments given to the soil samples were as follows:

1 and 2, 5 grams of soluble starch, check.

3 and 4, 5 grams of soluble starch, plus 210 mgm. CaCO_3 .

5 and 6, 5 grams of soluble starch, plus 250 mgm. KCl.

All the chemicals used in this work were added in solution.

The results are given in tabular form (table 1).

DISCUSSION OF RESULTS

The "Maquiling Area" comprises the following subdivisions or sub-areas; namely, Nanhaya-Mamatid, Santo Tomas, Alaminos, San Pablo, Calauan, Bay and Los Baños. The different soil series are in part the same as used by Dorsey (1903) in the Batangas Survey. A soil series consists of a group of soils differing in texture but having the same range in color, the same profile characteristics, particularly as to color and structure; broadly of the same type of relief and drainage and usually of a common or similar origin.

In an attempt to show the occurrence of *Azotobacter* colonies in the different soils used in the tests, as influenced by several factors under consideration, it seemed advisable to group all of the soils, according to the series, as they occurred in the different areas.

The soils of the Calumpang series are found to occur in the Nanhaya-Mamatid and Calauan areas. The organisms of the genus *Azotobacter* occur both in the surface soil and in the subsoil, samples of

which were used in the tests. It is apparent, however, that *Azotobacter* colonies were found to occur more abundantly in the surface soil than in the subsoil of the Calumpang series (Nanhaya-Mamatid Area) with an average pH of 6.09. The surface soils of the Calumpang series which occur in the Calauan area showed an average pH value of 5.78 and the subsoil an average pH value of 5.61. The addition of 210 mgm. of calcium carbonate (CaCO_3) to all soils stimulated the growth of *Azotobacter* organisms. The calcium treated plates showed a better growth of the organisms than the other plates which received potassium in the form of potassium chloride (KCl) and phosphorus in the form of mono-potassium phosphate (KH_2PO_4).

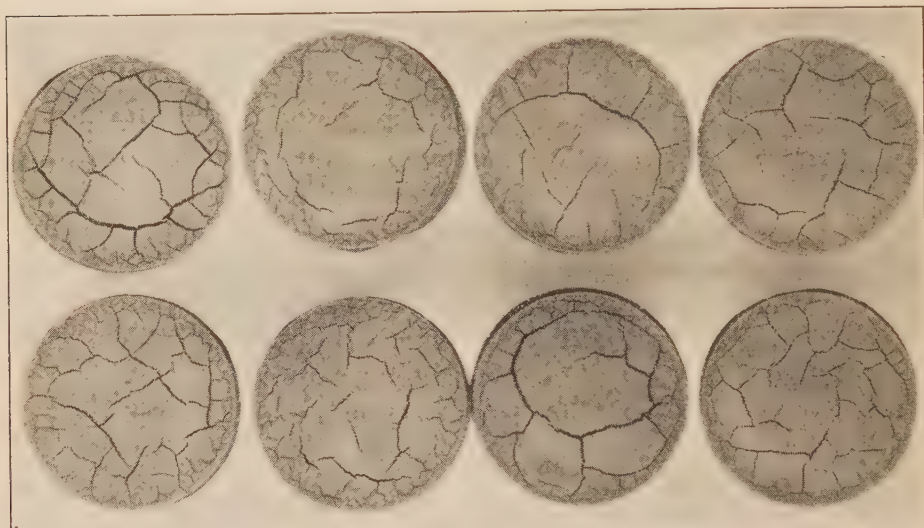


Fig. 1.—Plates showing the growth of *Azotobacter* colonies of the soil sample, Lipa light silty clay loam, No. 19-1 of the Santo Tomas area: (1) Check; (2) calcium carbonate; (3) potassium chloride; (4) mono-potassium phosphate.

The excellent growth of the organisms noted on the plates treated with calcium carbonate as illustrated in figure 1, may be attributed to the action of added calcium neutralizing the soil acidity which it has been claimed causes a depressing influence on the growth and activities of the *Azotobacter* organisms.

The soils of the Lipa series were found to occur in the Nanhaya-Mamatid, Santo Tomas, Alaminos, San Pablo and Calauan areas. From the results of their treatments, it is evident that in general the *Azotobacter* organisms occur in the surface soil as well as in the sub-

soil. The soils of the Lipa series occurring in the Nanhaya-Mamatid area did not seem to show a good growth of the *Azotobacter* organisms. It may also be noted that there was an insignificant difference between the reactions (pH values) of the surface soil and those of the subsoil of the Lipa series.

The depressing influence of the acid condition of the soils of the Lipa series on the growth of the organisms was clearly indicated by the presence of a greater number of colonies on the plates after calcium carbonate (CaCO_3) was added. It is of interest to note that the *Azotobacter* colonies found in the soils (Lipa light silty clay loam) of the Santo Tomas area appeared to be rather small and the plates were moldy. The addition of mono-potassium phosphate to

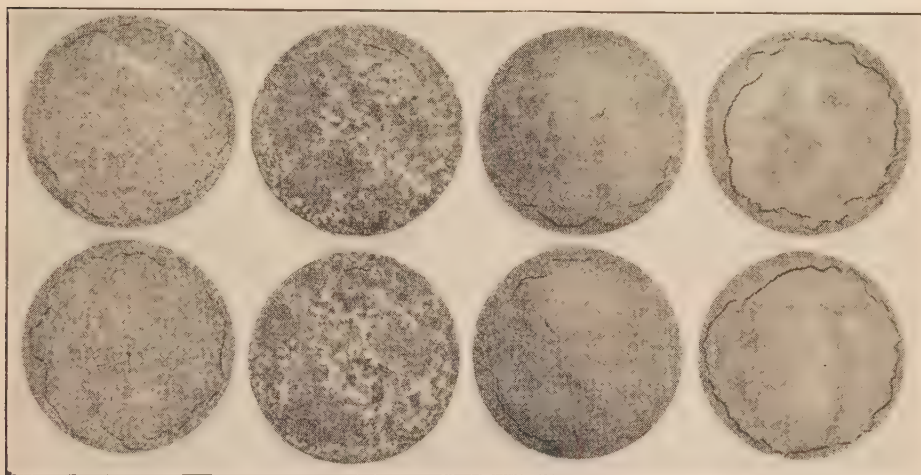


Fig. 2.—Plates showing the growth of *Azotobacter* colonies of the soil sample, Lipa light silty clay loam, No. 33-1 of the Alaminos area: (1) Check; (2) calcium carbonate; (3) potassium chloride; (4) mono-potassium phosphate.

the surface soils of the Lipa series seemed to exert a stimulating effect on the growth and development of *Azotobacter* organisms. Hence, it would appear that there is a deficiency of phosphorus in the surface soils of the Lipa series which occur in Santo Tomas area.

The soils of the Macolod series are found to occur in Santo Tomas, Alaminos and Calauan areas. As a result of the test the *Azotobacter* colonies in the soil type (Macolod clay loam) seemed to be uniform in appearance and distribution both in the surface and in the subsoil, there being no distinct difference in their reactions. It may be observed, however, that although that was the case the *Azotobacter* organisms did not occur uniformly in the rest of the treated

plates. The mono-potassium phosphate treated plates showed, in general, a greater number of *Azotobacter* colonies than those treated with potassium chloride. This phenomenon may be attributed to the apparent deficiency of phosphorus in the soil.

The Ibaan clay loam of the Nanhaya-Mamatid area showed a pH value of 5.77 for the surface and 5.88 for the subsoil. All of the treated plates showed an absence of *Azotobacter* colonies except in one case where calcium carbonate was added. It seemed apparent, therefore, that the soil reaction exerted a depressing influence on the growth of the organisms. The same soil type (Ibaan clay loam) of the Alaminos area was characterized by having an alkaline reaction, the surface soil showed a pH value of 7.70 and 8.00 for the subsoil. In this soil, *Azotobacter* organisms were found to occur only in the mono-potassium treated plates. This, again, seemed an indication of phosphorus deficiency in the soil. The Bay loam soil, having a pH value of 6.73 for the surface, did not seem to show a good growth of *Azotobacter* organisms. In the calcium carbonate and mono-potassium phosphate treated plates, however, a good growth of the organisms was observed. The subsoil of the Bay loam which has a rather more acidic reaction (pH 6.0) than the surface soil with a reaction of pH 6.73, showed no indications of the presence of *Azotobacter* colonies, except in the calcium carbonate treated plates.

SUMMARY OF CONCLUSIONS

1. The study of the occurrence of *Azotobacter* flora in soils studied may be accomplished by the use of Winogradsky's method.
2. In most of the soils studied the organisms of the genus *Azotobacter* occurred in both the surface soils and in the subsoils. These organisms, however, were found to occur more abundantly in the surface soils than in the subsoils.
3. The presence and activities of *Azotobacter* colonies in the soils are greatly influenced by the soil reaction; the most favorable growth of the *Azotobacter* was observed in soils having pH values ranging from 5.42 to 6.73. In more acid soils, as Lipa silty clay loam, No. 18-1, of the Santo Tomas area, which had an average pH value of 5.51 the *Azotobacter* colonies appeared rather small in size and the plates were moldy.
4. The addition of lime appeared to exert a favorable influence on the growth and development of *Azotobacter* colonies.

5. From the results obtained it appeared that the addition of phosphorus to most of the soils used in the tests showed a stimulating effect upon the growth of *Azotobacter* flora.

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TABLE 1
Showing the different soil types, reactions and the occurrence of *Azotobacter* colonies as influenced by the different treatments

SAMPLE NO.	DEPTH OF SAMPLE	SOIL TYPE	LOCATION OF SAMPLE	SOIL REACTIONS		TREATMENTS					
				Actual pH values ^b	Average pH values	Check ^b	CaCO ₃ ^b	KCl ^b	KH ₂ PO ₄ ^b		
1. Calumpang Series											
5-1 ^a	0-25	A. ^a Calumpang clay	Nanhaya-Mamatid	6.17	—	++	++	+	++ ^c		
7-1	0-25	Calumpang clay		5.65	—	+	++	+	++		
9-1	0-20	Calumpang clay loam		6.12	—	++	++	++	++		
12-1	0-25	Calumpang clay		5.99	—	+	++	++	++		
15-1	0-25	Calumpang silt loam		5.49	—	+	++	—	—		
16-1	0-25	Calumpang loam		5.49	5.82	+++	+++	—	+		
5-2	30-75	B. Calumpang caly	Calauan	6.63	—	++	++	+	++		
7-2	35-55	Calumpang clay		5.69	—	+	++	+	++		
9-2	30-50	Calumpang clay loam		6.16	—	+	++	+	+		
12-2	40-60	Calumpang clay		6.48	—	+	++	+	++		
15-2	45-75	Calumpang silt loam		5.54	—	—	++	—	—		
16-2	40-60	Calumpang loam		6.05	6.09	++	+++	—	+		
1-1	0-20	A. ^a Calumpang clay	Calauan	5.70	—	+	++	+	+		
2-1	0-30	Calumpang loam		5.40	—	+	++	+	+		
10-1	0-30	Calumpang loam		6.40	—	++	++	+	+		
11-1	0-25	Calumpang clay loam		6.60	—	+	++	—	+		
46-1	0-20	Calumpang clay loam		5.30	—	++	++	—	—		
47-1	0-15	Calumpang clay loam		5.30	5.78	++	++	—	—		

^a "A" and "1" indicate surface soil; "B" and "2" indicate subsoil.

^b Results given are averages of duplicate determinations.

^c + indicates presence of *Azotobacter* colonies; — indicates absence of *Azotobacter* colonies; ++ regular growth of *Azotobacter* colonies; +++ heavy growth. These explanations apply throughout the table.

SAMPLE NO.	DEPTH OF SAMPLE	SOIL TYPE	LOCATION OF SAMPLE	SOIL REACTIONS		TREATMENTS			
				Actual pH values ^b	Average pH values	Check ^b	CaCO ₃ ^b	KCl ^b	KH ₂ PO ₄ ^b
	<i>cm.</i>								
1-2	25-45	B. Calumpang clay	Nanhaya-Mamatid	5.60	—	+	++	—	—
2-2	40-50	Calumpang loam		6.40	—	—	+	—	—
10-2	30-65	Calumpang loam		5.70	—	+	++	—	—
11-2	30-60	Calumpang clay brown		5.50	—	+	++	—	—
46-2	35-55	Calumpang clay loam		5.30	—	+	++	—	—
47-2	50-60	Calumpang silt loam		5.20	5.61	—	++	—	—
		II. <i>Lipa Series</i>							
6-1 ^a	0-20	A. ^a Lipa clay loam		5.67	—	—	++	—	— ^c
8-1	0-25	Lipa light silty clay loam		5.70	—	+	++	+	+
14-1	0-20	Lipa light silty clay loam		5.80	5.72	—	++	+	+
6-2	25-40	B. Lipa clay loam	Santo Tomas	5.87	—	+	++	—	—
8-2	30-55	Lipa light silty clay loam		5.70	—	—	++	+	+
14-2	30-50	Lipa light silty clay loam		6.26	5.94	+	++	—	—
18-1 ^a	0-25	A. ^a Lipa light silty clay loam		5.51	—	+	++	+	+
19-1	0-25	Lipa light silty clay loam	Lipa loam	5.70	—	+	++	+	+
20-1	0-30	Lipa loam		5.55	—	+	++	—	+
21-1	0-25	Lipa clay loam (eroded)		5.40	—	+	++	—	+
25-1	0-20	Lipa light silty clay loam		5.40	5.51	+	++	—	+
18-2	45-65	B. Lipa light silty clay loam	Lipa loam	5.45	—	—	++	+	—
19-2	40-60	Lipa light silty clay loam		5.50	—	+	++	+	+
20-2	40-60	Lipa loam		5.52	—	—	++	—	—
21-2	40-60	Lipa clay loam		5.50	—	+	++	+	+
25-2	45-60	Lipa light silty clay loam		5.48	5.49	+	++	+	+

SAMPLE NO.	DEPTH OF SAMPLE	SOIL TYPE	LOCATION OF SAMPLE	SOIL REACTIONS		TREATMENTS			
				Actual pH values ^b	Average pH values ^b	Check ^b	CaCO ₃ ^b	KCl ^b	KH ₂ PO ₄ ^b
	cm.								
26-1 ^a	0-25	A. ^a Lipa clay loam	Alaminos	6.40	—	+	++	—	+
28-1	0-25	Lipa clay loam		6.40	—	+	++	—	+
29-1	0-20	Lipa clay loam		6.00	—	+	++	—	+
30-1	0-15	Lipa clay loam		6.40	—	+	++	—	—
31-1	0-25	Lipa light silty clay loam		6.70	—	+	++	—	—
33-1	0-25	Lipa light silty clay loam		6.40	6.38	++	++	+	+
26-2	35-50	B. Lipa clay loam		6.10	—	+	++	—	+
28-2	40-60	Lipa clay loam		6.50	—	+	++	—	+
29-2	35-55	Lipa clay loam		6.40	—	—	++	—	—
31-2	45-65	Lipa clay loam		6.50	—	+	++	—	—
30-2	20-25	Lipa light silty clay loam		6.50	—	+	++	—	—
33-2	50-60	Lipa light silty clay loam		6.50	6.41	+	++	—	—
40-1 ^a	0-20	A. ^a Lipa clay loam	San Pablo	5.31	—	+	+	—	—
41-1	0-25	Lipa loam (heavy)		5.68	—	+	++	+	+
42-1	0-25	Lipa loam		5.70	—	++	++	+	+
43-1	0-20	Lipa loam		5.51	—	++	++	—	+
44-1	0-25	Lipa loam		5.87	.561	++	+	—	—
40-2	45-55	B. Lipa clay loam		5.41	—	+	+	—	+
41-2	45-60	Lipa loam		5.51	—	—	+	—	—
42-2	45-50	Lipa loam		5.65	—	+	++	+	+
43-2	35-45	Lipa loam		5.51	5.52	+	++	—	+

SAMPLE NO.	DEPTH OF SAMPLE	SOIL TYPE	LOCATION OF SAMPLE	SOIL REACTIONS		TREATMENTS			
				Actual pH value, ^b	Average pH values	Check ^b	CaCO ₃ ^b	KCl ^b	KH ₂ PO ₄ ^b
3-1 ^a	0-18	A. ^a Lipa clay loam Lipa light silty clay loam Lipa light silty clay loam	Calauan	5.70	—	+	++	—	—
36-1	0-26			5.40	—	+	++	—	—
37-1	0-25			5.70	5.60	+	++	—	—
3-2	30-60	B. Lipa clay loam Lipa light silty clay loam Lipa light silty clay loam		5.40	—	+	++	—	—
36-2	35-50			5.30	—	+	++	—	—
37-2	35-60			5.50	5.40	+	++	—	—
III. <i>Macolod Series</i>									
23-1 ^a	0-25	A. ^a Macolod clay loam Macolod clay loam	Santo Tomas	5.34	—	+	++	—	—
24-1	0-30			5.51	5.43	+	+++	+	++
23-2	40-60	B. Macolod clay loam Macolod clay loam		5.31	—	—	++	—	—
24-2	60-100			5.50	5.40	+	++	+	+
27-1	0-20	A. Macolod clay loam	Alaminos	6.30	6.30	++	++	—	++
27-2	30-50	B. Macolod clay loam		6.40	6.40	++	+	—	++

SAMPLE NO.	DEPTH OF SAMPLE	SOIL TYPE	LOCATION OF SAMPLE	SOIL REACTIONS		TREATMENTS			
				Actual pH values ^b	Average pH values ^b	Check ^b	CaCO ₃	KCl ^b	KH ₂ PO ₄ ^b
	<i>cm.</i>								
4-1	0-15	A. Macolod clay loam	Calauan	6.20	—	+	++	+	—
38-1	0-25	Macolod clay loam		5.20	—	+	++	+	+
45-1	0-25	Macolod clay loam		5.20	—	+	++	—	—
48-1	0-20	Macolod clay loam		5.20	5.50	++	++	—	+
4-2	20-75	B. Macolod clay loam		5.50	—	+	++	+	+
38-2	35-55	Macolod clay loam		5.20	—	+	++	+	+
45-2	40-70	Macolod clay loam		5.20	—	+	++	—	+
48-2	45-55	Macolod clay loam		5.40	5.32	++	++	—	+
17-1 ^a	0-25	V. <i>Ibaan Series</i> A. ^a Ibaan clay loam	Nanhaya-Mamatid	5.77	5.77	—	+	—	—
17-2	35-65	B. Ibaan clay loam		5.88	5.88	—	+	—	—
32-1	0-18	A. Ibaan clay loam	Alaminos	7.70	7.70	—	—	—	++
32-2	50-60	B. Ibaan clay loam		8.00	8.00	—	—	—	—
13-1 ^a		V. <i>Bay Series</i> A. ^a Bay loam	Nanhaya-Mamatid	6.73	6.73	+	++	—	++
13-2		B. Bay loam		6.00	6.00	—	+	—	—

PUBLISHED CONTRIBUTIONS OF THE COLLEGE OF AGRICULTURE: X¹

B. M. GONZALEZ
Dean, College of Agriculture

Once more we present the yearly intellectual harvest of the College of Agriculture. So far, activity in this direction on the Los Baños Campus has not been hit by the depression. Research output, however, is essentially a product of human endeavor, and so long as we are able to keep an able force working contentedly, normal progress in the quantity and the quality of the work turned out should be forthcoming, as it has been in the past years.

We cannot help but view with a great deal of apprehension, however, the easy method being followed of dictating uniform and horizontal reductions in salaries in all lines of activity supported by government funds to balance the national budget. As a tax-supported institution the College of Agriculture has been subjected to this procedure. It reduces the personnel to a common level, and fails to properly appraise the true worth of the valuable individual. When prosperity comes once more, as it should eventually, these particular workers are easily spotted by industrial concerns willing to recognize their true worth, to the detriment of the work of the institution. It is apparent that experience must forever be the teacher of an infant country and particularly of one learning the first lessons in democracy. We can only hope for the best, and while we have it we wish to offer this list as the contribution of the College of Agriculture for the academic year 1932-1933 to the progress of Philippine agricultural science and practice.

II. EXPERIMENT STATION CONTRIBUTIONS

The contributions are numbered serially as reported. For Nos. 1-199, *see* THE PHILIPPINE AGRICULTURIST XII, No. 7, 1923. For Nos. 200-287, *see* THE PHILIPPINE AGRICULTURIST XIII, No. 10, March, 1925. For Nos. 288-354, *see* THE PHILIPPINE AGRICULTURIST XIV, No. 10, March, 1926. For Nos. 355-440, *see* THE PHILIPPINE AGRICULTURIST XV, No. 10, March, 1927. For Nos. 441-517, *see* THE PHILIPPINE AGRICULTURIST XVI, No. 10, March, 1928. For Nos.

¹ General contribution from the College of Agriculture No. 348.

518-595, *see* THE PHILIPPINE AGRICULTURIST XVII, No. 10, March 1929. For Nos. 596-643, *see* THE PHILIPPINE AGRICULTURIST XIX, No. 2, July, 1930. For Nos. 644-710, *see* THE PHILIPPINE AGRICULTURIST XIX, No. 10, March, 1931. For Nos. 711-799, *see* THE PHILIPPINE AGRICULTURIST XX, No. 10, March, 1932.

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- (833) OCFEMIA, G. O., and VICTORIA B. MENDIOLA. 1932. The *Fusarium* associated with some field cases of heart rot of abacá. The Philippine Agriculturist 21: 296-308. Fig. 1-3.
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III. GENERAL CONTRIBUTIONS

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- (325) SANTOS, F. O. 1932. What shall we eat? *Welfare Advocate* 6, No. 1; 9-10; 15-16; 24. No. 2: p. 5, 20.
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- (342) GONZALEZ, L. G. Bananas for export. *Graphic*, February 25, 1931.
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IV. CIRCULARS

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- No. 22.—VILLEGAS, VALENTE. 1932. Goat raising. (*See* Experiment Station contribution No. 812.)
- No. 23.—MONDOÑEDO, MARIANO. 1932. Curing pork and making sausage for home use. (*See* Experiment Station contribution No. 825.)
- No. 24.—ESGUERRA, JOSÉ P. 1932. Construction and operation of silos in the College of Agriculture. (*See* Experiment Station contribution No. 835.)

V. MISCELLANEOUS CONTRIBUTIONS

(From outside the College and translations)

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- (8) WOLTERECK, RICHARD. 1933. Endemism and the probable primary causes of organic evolution. *The Philippine Agriculturist* 21: 513-520. (Of University of Leipzig, Germany.)
- (9) MAGISTAD, O. C., AND O. N. ALLEN. 1933. Effect of liming on the growth of pigeon peas in Hawaiian soils. *The Philippine Agriculturist* 21: 654-664. *Fig. 1-3.*
- (10) DE JESUS, ZACARIAS. 1933. The resistance of the eggs and larvae of swine kidney worm, *Stephanurus dentatus* Diesing, with special reference to the control of stephanuriasis. *The Philippine Agriculturist* 21: 695-706.

A REVIEW: "HATCHERY MANAGEMENT"¹

The commercial production of baby chicks is an industry that bids fair to be profitable in the Philippines. *Hatchery Management* is the title of a book on this subject that has just been placed on the market. Poultry raisers in the Philippines, particularly those who are contemplating starting a hatchery and producing chicks on a commercial scale should make use of this book. They would find it of great help.

The book was written by Roland C. Hartman and G. S. Vickers. Mr. Hartman was formerly editor of *Hatchery Tribune* and at present is the editor of *Everybody's Poultry Magazine*. Mr. Vickers is the Field Manager of the Ohio Poultry Improvement Association, having been formerly a Poultry Extension Specialist of the Ohio State University. *Hatchery Management* contains a thorough and able discussion of the methods used by hatchery operators in the United States.

The subject matter treated in the book is distributed in twenty-nine chapters. The first two chapters are historical; an interesting description of the history of mammoth incubation is given in Chapter I and in Chapter II the development of commercial hatching in America is described.

Chapters III and IV give valuable pointers on establishing a hatchery business, where to locate the hatchery plant and how to plan the building to get the best results from the amount of space available. The suggestions on buying incubators and other hatchery equipment given in Chapter V will be found helpful, especially for a beginner in the hatchery business. In the next ten chapters, Chapters VI to XV, are discussed suggestions for securing good hatching eggs, methods of incubating these to give the best results, and successful methods for handling the chicks after they are hatched. These discussions will be found most useful by any one who is planning to run a baby chick business in the Philippines.

Eleven chapters, Chapters XVI to XXVI, are devoted to advertising and methods of selling baby chicks, feeds and supplies. As

¹ HARTMAN, ROLAND C., AND G. S. VICKERS, 1932. *Hatchery management*. xiv + 386 p., 108 fig. New York: Orange Judd Publishing Company, Inc.
General contribution from the College of Agriculture No. 333.

the market for baby chicks in the Philippines is yet to be developed, those who are planning to operate a hatchery in this country will find the suggestions given in these chapters of practical value in developing the market and creating a demand for their products.

In Chapter XXVII, the handling of complaints is described and helpful suggestions are offered. In Chapter XXVIII records that are essential in the operation of a hatchery are illustrated. In the concluding chapter, Chapter XXIX, the qualities that will make a successful hatchery operator are discussed.

The book is supplied with a good index. The goodly number of illustrations that the book contains aids in making it a useful companion for hatchery operators. For the improvement of future editions of this book, however, it is suggested that a separate chapter on the care, feeding and management of young chicks be added. This would surely make the book more useful to the hatchery operator, inasmuch as the authors themselves state that "most hatcheries now sell started chicks, some making this an integral part of their business...."

F. M. FRONDA

Of the Department of Animal Husbandry

ABSTRACT ¹

A study of cross-compatibility between talahib (*Saccharum spontaneum* Linn. Subsp. *indicum* Hack.) and other species of *Saccharum*. GERONIMO Y. CREAG. (*Thesis presented for graduation, 1931, from the College of Agriculture, No. 341; Experiment Station contribution No. 877.*)—This study was conducted in the Plant Breeding Field and Nursery of the Department of Agronomy of the College of Agriculture, Los Baños, from March 29, 1929 to December 1, 1930. The object of this study was to determine the cross-compatibility between talahib and other species of *Saccharum*.

The cane varieties used were Uba (small type), C.A.C. 87, P.B. 271, P.B. 272, Tigbao Mestiza, C.N. 18694, Co. 213, Co. 212, and P.O. J. 2878. These cane varieties were crossed with talahib as the male parent in most cases. Likewise, they were selfed to serve as control. When the crossed and selfed arrows were matured, the fuzz was sown

¹ Abstract prepared as part of required work in English 3a, College of Agriculture.

in seed boxes. The general condition and characters of the seedlings were observed, and then they were pricked. The following characters were studied: color of leaf blade, color of upper portion of leaf sheath, color of base of leaf sheath, manner of tillering, presence of hairs on the leaf sheath, presence of hairs on the upper surface of the fourth leaf blade, height of the highest shoot of the seedling, degree of tillering, and length of longest root when the seedlings were pulled up during transplanting after the soil was moistened.

It was found in this study that talahib produced abundant flowering stalks and that it can be used as a material for cane hybridization work.

The study of the selfed-seedlings and the supposed hybrid seedlings of these cane varieties and talahib based on the characters mentioned above showed the following results:

Talahib is cross-compatible with either Uba (small type), P.B. 271, C.A.C. 87, or Co. 212 as shown by the color of leaf blades, manner of tillering, presence of hairs on the leaf sheaths and presence of hairs on the upper surface of the fourth leaf blade of the seedlings produced. Talahib is cross-compatible with P.B. 271 and Co. 212 based on the study of color of the base of the leaf sheaths of the seedlings produced. Talahib is cross-compatible with Uba (small type), P.B. 271, and C.A.C. 87 based on the study of degree of tillering of their hybrid seedlings.

No evidences of cross-compatibility were found between talahib and either Uba (small type), C.A.C. 87, P.B. 271, Co. 213, Co. 212, or P.O.J. 2878 as shown by the color of the upper portion of the leaf sheaths, height of the highest shoot, and length of the longest root of the seedlings obtained. No evidence of cross-compatibility was found between talahib and either Uba (small type) or C.A.C. 87 based on the study of color of the base of the leaf sheaths of the seedlings produced. No evidence of cross-compatibility was found between talahib seedling F_1 and Co. 212 based on the study of degree of tillering of their seedlings. No selfed seeds from Tigbao Mestiza and P.O.J. 2878 were obtained, and the selfed arrows of Co. 213 did not germinate.

—*Abstract by Nazario Pidlaon.*

CURRENT NOTES

If your bottle of glue gets dry or old, just add a few drops of good vinegar, hot as can be, and lo! a new bottle of glue.

If the ink bottle gets "unruly," add vinegar to it.

If your fine picture frames are fly-specked, wash them with vinegar. They will become like new.

Hardened shoe blacking may be made like new with vinegar.

Leather made unusable by water may be softened by hot vinegar. Keep applying until in natural state.

Many kinds of stains, including shoe blacking, may be taken off with hot vinegar. Heating seems to add to the power of vinegar.

Moistening the hands with vinegar after laundry work will counteract the hard effect of water and soap.

Vinegar and salt will make brass faucets like new again.

Cheese wrapped in cloth wet with vinegar will remain fresh twice as long as otherwise.

Boil your jar tops in vinegar before using the second time.

All vegetables washed in water in which a little vinegar has been added will give up impurities not before suspected.

Grass stains will yield readily to vinegar if used before laundering.

All kinds of enamelware will remain new longer if vinegar is used on it occasionally.

Poached eggs may always be removed whole if you will add a few drops of vinegar when they are being cooked.

Hot vinegar will take that daub of paint off the window glass.

Accidents will happen, and should one get either lime, soda or ammonia in the eye, vinegar being acid, will counteract these at once, but it should be apple vinegar used for this.

A good and reliable simple furniture polish that will serve as finish to fine woods may be made with equal parts of turpentine and vinegar, shaken well and set away to ripen.

A vinegar bath after washing the hair will clear it of any suspicion of soap and make it soft and fluffy.

Southern Agriculturist, October, 1932

An explorer in the forests of Northern India has found a tree that gives an electric shock to anyone who touches it. The intensity of the shock varies with the time of day, the current being at its strongest at 2 p.m.

Few people in this country realize the extraordinary properties with which nature has endowed some trees. In Nubia, for example, there is a tree, the sofar, that plays tunes, a startling effect due to

the boring of numerous insects at the base of the young shoots. The wind, playing through the tiny apertures, produces a series of flute-like notes.

A Canadian prairie tree, known as the compass tree, is the infallible guide to travellers, the edges of its leaves always pointing north and south.

In Arizona there is a tree which, on being touched, actually ruffles its leaves and tries to scare off the intruder by emitting a sickening odour.

Tasmanian Fruitgrower and Farmer, October 1, 1932

Denmark has the proud distinction of leading the world today with the highest average production as shown by her cow testing associations. In some parts of Denmark as high as 70 per cent of the dairy cows are under test. This is particularly true in the best breeding sections where breeding stock is produced. Note the influence of testing on the islands of Denmark:

Year	Cow on test per cent	Lbs. milk produced	Test	Lbs. fat produced
1900-01	5	6,493	3.39%	220
1910-11	20	7,260	3.55%	257
1920-21	24	7,337	3.64%	268
1929-30	48	8,217	3.86%	317

The information secured through the testing associations is not only made use of for calculating the feeding requirements and profits of production of each cow but is also the basis of selection of all breeding animals and is the basis of all other factors used in cattle improvement.

The Journal of the Jamaica Agricultural Society, July, 1932

The total production of fruits and nuts in the Philippine Islands in 1931 was valued at ₱28,518,970, while the import value over the export value of these products was approximately ₱2,000,000. The total value of fruits and nuts consumed in the country was therefore ₱30,517,970 for a population estimated at 13,000,000, or a per capita consumption valued at only ₱2.34. This rate of consumption is indeed too low. This rate should at least be tripled.

Philippines Farm Journal, September, 1932

Cold potatoes used instead of soap will clean the hands and make the skin soft and smooth. The water in which the potatoes have been boiled is excellent for sponging the dirt out of silk. Potato water, made by grating a potato into about half a pint of cold water and afterwards straining it, is splendid for cleansing purposes.

The Farmers' Gazette, October 15, 1932

COLLEGE AND ALUMNI NOTES

The College Physician, Dr. Sixto Francisco with Mrs. Francisco and their daughter Tessie, returned to the Philippines on December 11, 1932 from a six-months tour abroad. Doctor Francisco was a delegate to the 1932 Conference of the World Federation of Education Associations held in Honolulu. He was in Los Angeles during the World Olympics. Here, and later in several American universities, he gathered data on students' competitive athletics with relation to health of athletes, a subject he has been studying on the Campus. In Europe he studied in Vienna for six weeks, and in other cities made special investigation on tuberculosis among students. In both United States and Europe, Doctor Francisco studied practices in the relation of health service and athletes in the universities.

After his return, Doctor Francisco read two papers on the subjects of his studies abroad at the Annual Philippine Medical Association Convention. He was honored by being elected vice president of the association. Doctor Francisco returned to duty at the College Infirmary on January 1.

Mr. Gavino Tabuñar, President of National University, Manila was a Campus visitor on December 29. He was accompanied by Mr. Placido Dacanay, Chief of Investigation, Bureau of Forestry. Both Mr. Tabuñar and Mr. Dacanay are interested in back-yard poultry raising. Doctor Fronda showed them around the College Poultry Plant.

A chapter of Phi Kappa Phi, American honorary scholastic society, was installed in the University of the Philippines on January 17, with Mr. Richards of Iloilo, Iloilo, as installing delegate of the

Central organization. The officers elected for the U. P. Chapter were: Dean B. M. Gonzalez, President; Dr. H. B. Reyes, Secretary-Treasurer; Dr. Vidal A. Tan, Corresponding Secretary.

Agriculture and Forestry Notes, University of Nanking, under date, January, 1933, carries the following note: "Dr. Robert L. Pendleton of the National Geological Survey, Peiping spent two weeks in Nanking for the purpose of giving a series of lectures on soils to the students of the Winter Institute."

Doctor Pendleton is head of the Department of Soils in this College. He is on leave this year conducting soil surveys in China.

It may not be generally known on the Campus that Dr. Miguel Manresa is official collaborator in *Biological Abstracts*, "a comprehensive monthly abstracting and indexing journal of the world's literature in theoretical and applied biology, exclusive of clinical medicine." Doctor Manresa did abstracting for *Biological Abstracts* off and on while he was studying in the University of Wisconsin. When he returned to the College the Dean asked him to continue this work with special attention to the articles in the THE PHILIPPINE AGRICULTURIST. In November, 1931, his work was recognized by the Union of American Biological Societies, the publishers, and his appointment received official confirmation with special assignment to abstracts of articles in THE PHILIPPINE AGRICULTURIST.

An article "Poultry raising in schools" by Dr. F. M. Sacay which was published in the *Philippine Poultry Journal* in June, 1932, was reprinted in the November, 1932 issue of *Chanticleer, The Modern Poultryman* (England).

The seventy-ninth meeting of the Los Baños Biological Club was held on Thursday, December 15, 1932, at 7:30 p.m. in the Poultry Husbandry lecture room of the College of Agriculture, Los Baños, Laguna.

The following papers were read and discussed:

"Characteristics of Power Consumption Curves of Some Tractor Engine Fuels" by Dr. A. L. Teodoro, S. R. Cruz, and E. M. Bautista. Paper read by Mr. Cruz.

"The Digestibility of Flint Corn Silage by the Carabao" by Mr. A. T. Taleon, Dr. V. Villegas and Mrs. Mamerta Manahan Ilagan. Paper read by Mr. Taleon.

On the evening of January 14, Dr. Sixto Francisco gave a talk at the Christian Social Center on his observations while abroad on the relation of athletics to health of College students. Also his observations on the World Olympic Competitors at Los Angeles. The talk was under the auspices of the Christian Endeavor Society.

At the close of the talk Juan Acasio, president of the society presented an ambulatory bookcase to the College Infirmary. The case is on wheels so it can be rolled to the bedside of a patient thus allowing him to select his reading.

The society is undertaking to supply some books, papers and magazines. For some weeks this society has been sending flowers to the Infirmary.

Mr. Thongdee Resananda '24 writes Doctor Fronda that he is now located in southern Siam in the Agricultural Teachers' Training School, Kuan Niang Station, Southern Line. "I am now doing double duty of being the head of this school and the head of the experiment station. Both have been recently established." Being selected for this position is a tribute to Mr. Resananda's success as principal of the Agricultural School of Korat. Mr. Iang Chandrastitya '21 is now principal of this school.

Mr. Resananda further writes "I have read with very much interest about the Cantonese you originated. So much so that I recommended the breed to the Director of the Agricultural Department for trial. He agreed with my views and ordered me to ask further information from you. Will you please tell me if you have some stock to spare in case an order is made? If so, please quote prices including transportation to Bangkok."

Many in the College will read with sorrow and regret the following extract from a recent letter from Mr. Resananda to Professor Yule: "Mr. Paul Sindhuravejna (B. S. Agr. '25), poor fellow is no

more. Death took him about three months ago. His worth is now felt by the Ministry circles and everybody regrets his untimely departure for that 'bourne from which none returns'."

The Fourth Students' Conference was held in the Protestant Chapel grounds December 26-30. In attendance and interest and in work it was pronounced most successful. The development of these conferences is most gratifying. This is the second interdenominational conference. The Aglipayan, Baptist, Catholic, Disciples Iemelief, Methodist, Mohammedan, and United Evangelical denominations were represented. The registration was 140. There were 22 provinces represented and one delegate from Java. Among the principal convocation speakers were Dr. I. Panlasigui, Dr. Rebecca Parish, Dr. G. W. Wright, Dr. Gavino Tabuñar, Dr. J. P. Jockensen, Dr. R. Regala and Mrs. A. Perez. On the last evening, "Why the Chimes Rang", a pageant was presented under the direction of Mr. and Mrs. Hugh Bousman.

Assistant Professor Anne Cole of the Department of English and Miss Laura Mae Williamson of the Rural High School made the "Circle" trip in the rice terrace regions in the Mountain Province in the Christmas holiday recess.

In a letter to Dean Gonzalez, Mr. Felicisimo D. Suratos '32 tells about a crop and live stock farm he is opening in Diadi about 28 kilometers from Bagabag, Nueva Vizcaya. He feels that he is a real pioneer—as he is—for he receives mail only once a month. As to his farm, he writes—"The pasture areas here are abundant and the growth of grasses is luxuriant throughout the year. Streams for watering the animals are also numerous. The problems confronting cattle raisers are distance from market, lack of capital, and cattle thieves The only ranch having the best kind of cattle is owned by Mr. A. Abesamis, an alumnus of the College. The cattle raisers are practical men who do not even use castration and proper selection of bulls and breeding cows."

Mr. Abesamis is a 1921 graduate.

Another pioneer is Constantino Derecho, '27 who is developing his homestead which he has named Passe Farm. The homestead is located in Ubi, Cotabato. He has two tenants working with him.

Jorge A. Tingzon, '31, is working on an hacienda in Pagsaňgan, Bondo, Mulanay, Tayabas. The hacienda, which covers an area of about 800 hectares, is a branch of the Matsouka Development Company of Davao. Rice and coconuts are the principal crops grown on the plantation.

Alfonso Briones, '29, of the Philippine Sugar Association, was on the Campus recently to get some shade trees and ornamental plants from the Agronomy Department.

Telesforo Tioaquen, '33 (graduated June, 1931), is working with Mr. Carlos Sandico, an extension alumnus, Poultry Class of 1931, in developing Mr. Sandico's poultry farm in Mexico, Pampanga. The farm has a little over 600 layers, mostly Los Baños Cantonese.

Mr. Felix F. Villa, '28 was a visitor on the Campus on December 26. Mr. Villa is manager of Hacienda Lopez, Nasugbu, Batangas.

Mr. Felix S. Gamo, '31 is working as poultryman for Mr. Jose Fabella, Public Welfare Commissioner, Manila. Mr. Gamo was the former poultryman on Elvi Poultry Farm, San Juan Heights, Rizal and Baguio Poultry Farm, Baguio, Mountain Province. Mr. Juan S. Padilla, '32 succeeded him on the Baguio Poultry Farm.

Reliable reports state that Martin Caliňgasan, '27, is operating a farm in Muntinlupa, Rizal. Buenaventura M. Aguanta, '30, is acting superintendent of Halcon Rubber Experiment Station located in Baco, Mindoro. Victor F. Burgos '26, is now farming in Parang, Cotabato. Gaudencio B. Cruz, '31, is engaged in fishing and raising ducks in Pila, Laguna.

IN MEMORIAM

ANTONIO L. ROCAFORT. B. Agr. '22; B. S. Agr. '24.
Assistant in Department of Engineering 1922-1929;
instructor in physics 1929-1932.

January 17, 1933

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